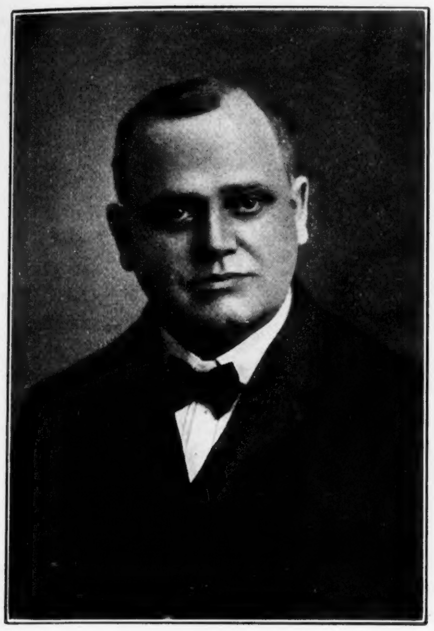
MACHINERY.

December, 1903.

TOOL MAKING.—1.

A WORD TO THE BEGINNER—CUTTING SPEEDS—REAMERS.

E. R. MARKHAM.


E. R. Markham.

In many shops the term "toolmaker" is unknown, or, if known, is seldom used; the term "machinist" is applied to the class of men doing the general machine work, as well as to those making jigs, fixtures, gages, and cutting tools.

Until the advent of interchangeability of the parts of machines and of other products of machine shops, the use of jigs, fixtures, etc., was not generally known. The work was done mostly by what was then termed skilled labor and even then the assembling of the article was done by skilled workmen, because it was necessary to fit the various parts to each other.

It was found that by the use of suitable fixtures, jigs, etc., to hold the work and guide the cutting tools, work could be made to gage, which, of course, facilitated matters very much when the article was assembled. As this system of working was perfected, it was found that if these fixtures, jigs, etc., were made sufficiently accurate the various machining operations could be done by other than skilled workmen, thus materially reducing the cost of manufacture. As these men became accustomed to the work they were doing, they could, by the aid of accurate gages, produce work that could be assembled by unskilled help much faster and in a more satisfactory manner than it was formerly possible with skilled labor.

But in order to make the fixtures, jigs, gages, and cutting tools sufficiently accurate to produce work of the desired quality, it was necessary to educate the machinist to a point where he could do the work more accurately.

The system of interchangeability of parts was not a thing to be accomplished in a minute; it has been a gradual development that took over forty years, and is to-day far from being realized in many shops.

The machinist who has had this higher education is generally termed a toolmaker. In large shops where there is enough work of one kind to keep a toolmaker busy, one man is given the gages to make, another the jigs, another the dies, and another the models. These men are then called gage makers, jig makers, die makers, and model makers, respectively. The object attained is that a man working on one class of work all the time will be more skillful in this one line than if he were working on various classes of work. In most shops, however, it is expected that the toolmaker will make all the fixtures, jigs, models, and cutting tools. The fact that, generally speaking, there is enough tool work to keep a toolmaker occupied all the time, has led some men to learn to make tools without learning the trade of machinist; but, however skillful this man may be, he is handicapped, because he may at any time be called on to build *special* machinery. This is generally considered work that should be given a machinist who has the experience of working on tool work, and unless a toolmaker understands the principles involved in machine construction he is liable to slip up, no matter how skillful he may be as a workman.

Machinery used in the construction of tools, as well as that employed in their use, has changed very much during the past forty years; yes, even within the last ten years there have been many radical changes which tend to make more practical the construction of tools used in producing duplicate work. And not only has machinery been perfected, but measuring tools are now built that make it possible to work within a limit of variation that was not dreamed of a few years ago. As measuring tools have been perfected, methods have been devised whereby work can be done very accurately, in less time than it was formerly possible to do a half passable job.

In constructing special machinery, fixtures, jigs, etc., it was formerly the custom in many shops to give a man a piece of work, or a templet, describing to him roughly what was wanted, and letting him go ahead himself and make the article. Everything was done by a "cut and try" method, and the result was often anything but satisfactory, both as regards practical utility and cost of construction. To-day the custom in most shops is to make drawings of all tools of this character, the drawings, or at least the designing being done by one man. These all agree as to working dimensions and working or locating points. How common it was under the old system to find a drill jig designed so that the piece of work was located from a certain point or surface, and the milling machine or other fixture designed to locate from an entirely different point, thus making it impossible to produce duplicate work!

Where one man makes designs for all the tools that go with a certain piece he makes them so that the working points of his jigs, fixtures, and gages agree; and when it is necessary, for any reason, to change a locating point he makes sure that in so doing he does not undo all he is attempting to accomplish and for which he is to build costly tools.

To attain success as a toolmaker a man should have a certain amount of education. He must be able to read a drawing, he must understand decimal fractions, and must be able to add, subtract, multiply, and divide both whole numbers and decimals. Right here I think I hear some one saying that "one of the best workmen he ever knew couldn't add 3 and 2 and get the proper answer—to say nothing of decimals." Well, what a valuable man this fellow would have been had he had a good education!

I recall a man who was in my employ for several years, who was an excellent workman, yet he could not take a drawing and work from it without having it explained to him, and as to anything that involved a knowledge of arithmetic, he was all at sea and some one had to do it for him. This man often deplored his lack of knowledge, and said he "would give a good deal" if he could take a drawing and figure out the calculations necessary to a proper understanding of it.

The man who wishes to become a successful toolmaker should also learn to work *accurately*. Accuracy is very essential in places where it is necessary; yet undue accuracy is never to be indulged in, because it consumes valuable time. If within 1-16 inch is near enough, it is folly to spend the time necessary to work within a limit of variation of 1-10,000 inch. But there are places where the latter limit of variation—or even less—must be observed, and in such cases the required time must be taken to do work of this character.

The successful toolmaker discriminates between the portions that must be approximately correct and those that must be exact, and governs himself accordingly.

As an example of the two classes of measurements under consideration, we will take a plug gage like that shown in Fig. 1. Now, it is essential that the portion marked *A* be *exact size*. The utmost care must be exercised when grinding and lapping to size, as no variation from the size given would be allowable. But when machining the portions marked *B* and *C* no such accuracy is necessary, neither is it desirable that time be spent on these to get them accurate within a limit of variation of 1-32 inch. Not that any such variation as this should be indulged in when dimensions are given, but the variation mentioned would not in any way affect the accuracy of the tool or its efficiency as a gage.

For the benefit of the beginner let us consider a few points that must always be observed if we want satisfactory work. The center punch should have a good sharp point, which should be at an angle of about 60 degrees. This angle is given not because absolutely essential, but because it is generally customary to make at about this angle, and it is always best for the beginner to have something definite to work to—it tends to make him a more careful workman.

He should be careful as to the condition of his center reamer, which should not only be sharp but should be exactly the shape of the centers of his lathe—generally 60 degrees.

It is impossible to do accurate turning if the countersinking in the end of the piece to be turned does not fit the lathe center. Fig. 2 gives two views showing the results when the countersink is not the same shape as the point of the center.

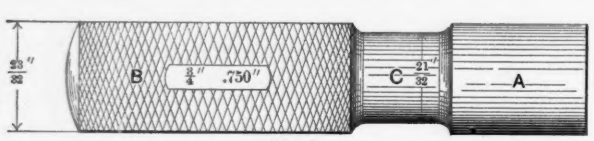


Fig.1

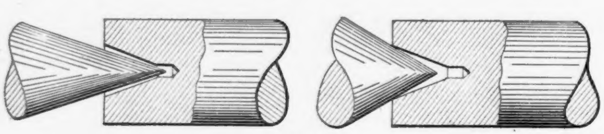


Fig.2

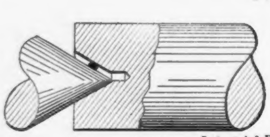


Fig.3

Industrial Press, N.Y.

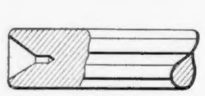


Fig.4

It is also highly important that the centers of the lathes fit well in the spindles, that they fit the center gage accurately, and that the live center runs true. It is especially necessary when the finish cut is taken on a piece. Many toolmakers never think of taking a finish cut after roughing without truing up the live center; or, if they find it necessary to remove the live center from the spindle, they always true it after returning to place before taking any finishing cuts.

Another precaution that is sometimes neglected is to always be sure there is no dirt in the spindle hole, or on the shank of the center before it is put in place. Then, again, he should always make certain that there is no dirt in the countersunk hole or on the point of the center, as this will cause the work to run out of true when the dirt is removed. I have seen valuable pieces of work ruined because of lack of attention to this simple precaution. A man turned a piece to grinding size—.005 inch to .008 inch large; when it was taken to the grinder he cleaned the centers out carefully and removed a chip which had become imbedded in the piece. When turning in the lathe this chip held one side of the countersunk surface from the center, as in Fig. 3, and when this chip was removed the piece ran out so badly that it was not possible to true it, consequently it was of no value.

When countersinking the ends of a piece of stock care should be taken to use a drill of *suitable* size, and not to make the countersinking out of proportion to the size of the piece. It looks unmechanical, to say the least, to see a 5/8 inch reamer having a countersunk hole in the end, of the size shown in Fig. 4; and it *is not* mechanical, as it weakens the reamer, which is very apt to break when in use, or is more liable to crack when being hardened than if it were countersunk the proper depth.

A peculiarity of steel—both machinery and tool steel—is that it is very liable to go out of straight when the surface—skin—is removed. For this reason it is always advisable to rough the piece all over, removing all the exterior surface before finishing any portion to size.

A point I hesitate about mentioning because careful workmen will say that "any boy should know that," is that when starting to machine a piece in the lathe the ends should always be squared to length first, or at least before any portion is turned to size; and all work on the ends that is in any way liable to affect the center should be done before sizing any portion, otherwise the work may be thrown out of true.

Cutting Speeds.

The metals generally worked when making tools are cast iron, machinery steel, and tool steel. A workman who has the welfare of his concern at heart will always use speeds and feeds best adapted to the work he is doing, that he may turn out the maximum amount of work. Generally speaking, it is possible to run at faster speeds and use coarser feeds when machining cast iron than when either machinery steel or tool steel is being cut. The speed which gives best results when machining any form of iron cannot be stated arbitrarily, as very much depends on the condition of the metal being cut, and also on the condition of the cutting tool. Yet it is necessary to know the speeds that give best results under ordinary circumstances. It has been ascertained by experiment that the following rates of speed give good results under ordinary conditions: Cast iron, 40 feet per minute; machinery steel, 30 to 34 feet per minute; tool steel, 20 to 25 feet per minute. If the cut is light and the metal soft, these speeds may be exceeded, but if the cuts are heavy or the metal hard it will be found necessary many times to run much slower.

In order to know how fast to run the machine, for stock of various diameters, the following simple rule is given: Multiply the diameter of the piece in inches by 3.1416 to obtain the circumference, or the distance around the outside of the piece; now reduce the number of feet the piece should be run per minute to inches. That is, if it is cast iron, reduce 40 feet to inches; $40 \times 12 = 480$. Then divide 480 by the circumference of the piece to be turned in inches and the answer will be the number of turns per minute at which the lathe should run. If the workman is not familiar with decimal fractions, he may multiply the diameter of the piece by 3 1/7, instead of 3.1416.

To illustrate the above, suppose we were to turn a piece of machinery steel 3½ inches diameter and desired to know the correct speed to run the lathe, first multiply 3.1416 by 3½ inches and our answer is 10.99. We next reduce 34 feet—the speed we can run machinery steel at—to inches, 34×12 inches $= 408$ inches; then divide 408 inches by 10.99 and we get as our answer 37 and a fraction. So we know that in order to get good results as to time we must have the lathe run about 37 revolutions per minute. The experienced mechanic can tell by observation when a piece of stock is running at about the right speed, but for the benefit of those whose experience is somewhat limited the above is given.

Reamers.

The principles involved when making tools can best be explained by considering each tool or class of tools separately. We will first consider the reamer.

The reamer is a tool used in making a hole true to size and smooth. The term "reamer," however, is oftentimes applied to a tool used to enlarge a cored hole, or a hole already drilled, without any reference to the size or condition of the hole. Reamers may be arranged in classes, according to shape, as follows: Straight reamers, taper reamers, and formed reamers. They are made solid, adjustable, and with inserted blades, which constitute the cutting teeth.

Solid reamers are made of *one* piece of stock, and are so named because the cutting teeth and head are solid with each other; they are not adjustable as to size. Fig. 5 shows a solid,

fluted reamer. Inserted blade reamers are so called because the cutting teeth or blades are made from separate pieces of steel and inserted in slots in the head, as shown in Fig. 6. When making the adjustable form of reamer, we can have the cutting teeth solid with the head, or the reamer may be made with inserted blades, but it must have some means of adjustment as to size.

Fluted Hand Reamers.

The first form of straight reamer we will consider is the fluted hand reamer. This is straight on the cutting portion, except for a short distance at the end, as shown at *A*, Fig. 5, which portion is slightly tapered so that the end of the reamer may enter the hole.

In selecting tool steel for tools whose cutting edges are around the circumference of the piece it is necessary to take stock somewhat larger than finish size in order that the decar-

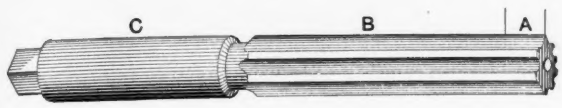
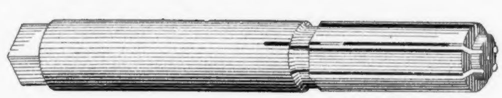


Fig. 5



Industrial Press, N.Y.

Fig. 6

bonized portion at the surface may be removed. This surface becomes decarbonized by the oxygen of the air acting on the carbon at or near the surface of the steel when it is red hot, during the various operations in the steel mill and forge shop; and if this portion is not removed it will be found impossible to harden the very parts we wish hard. Knowing this, we select stock 3-32 to 1/8 inch larger than finish size.

When centering, be sure and have the centers central with the outside of the piece, as shown in Fig. 7, so that an equal amount of the decarbonized portion may be removed all around the piece. Should the piece be centered as shown in Fig. 8 we must necessarily remove all the decarbonized portion on one side and very little on the other, and when the article is hardened it will be found hard on one side and soft on the opposite side; or, if this side is hardened at all it will not be as hard as that opposite, and, moreover, the piece will be very apt to spring from the unequal contraction on the opposite sides of the piece.

Having centered the piece properly, first square the ends to length and clean all burrs and dirt out of the center hole. Turn a chip off the outside surface to a depth of 1-32 inch, then anneal the steel. It is advisable to anneal before turning to size, even though the steel may be soft enough to work well without it, the object being to remove the strains set up in the steel mill by the various operations of rolling and hammering, otherwise these strains may be set up in the forge shop when the piece is forged to shape. When the piece is heated for annealing the tendency to crack or spring when it is hardened is overcome or reduced to the minimum.

The method to be pursued when annealing depends on the facilities afforded in the shop where the work is done. If we have at hand the necessary furnaces and annealing boxes, it is a good plan to pack the steel in charcoal—finely granulated—in an annealing box, place in a furnace and run for a sufficient length of time to have the steel become uniformly heated. The box should be removed from the furnace and allowed to cool slowly. An excellent method consists in placing the steel when red hot in *hot* lime or ashes, burying it well and allowing to cool as slowly as possible. It must not, however, be placed in damp or cold lime or ashes.

If the piece of steel from which we are to make the reamer is comparatively short there will be little liability of its springing by the process of annealing; but if it be long it is very liable to spring from the cause mentioned; that is, from the strains due to uneven heating or cooling, or that may be set up by the operation of rolling or hammering in the steel mill or forging in the forge shop, which manifest themselves as the steel heats. Consequently the steel crooks. Now, if the tool is to be hardened after it is completed the steel must not be straightened when cold. Should it spring enough so it could not be machined without straightening, it must be heated red hot and straightened, as otherwise it is almost sure to spring when it is hardened.

After annealing clean out the center holes with the center reamer, in order that no scale or dirt of any sort be in them, then turn *B* and *C*, Fig. 5, to sizes from .010 to .015 inch larger than finish size, necking down between cutting portion and shank, as shown. It is always advisable to mill the square portion before cutting the flutes. This is usually done by holding the reamer between centers on the milling machine and elevating the knee of the machine, thus feeding the stock to be cut up past the milling cutter, which must, of course, be an end mill. After the cut has been taken and the knee of the machine has been lowered, the index head of the milling machine may be revolved one-quarter turn, which places the reamer in position for the next cut. This must be continued until all four of the square sides are milled. After milling the square portion to size, a suitable dog may be placed on the square end, and the flutes which form the cutting edges may be milled.

Some manufacturers of reamers mill the flutes straight, while others claim best results if the teeth are cut spiral, using what is termed a left-hand spiral in order that the reamer will not have a tendency to draw into the work, as would be the case were the opposite spiral used.

Mechanics generally agree that a reamer with straight teeth gives good results when reaming holes in sound stock, or where there are no grooves or other depressions in the walls of the hole; when these difficulties are encountered then the reamer with the teeth cut spiraling seems to be the most satisfactory.

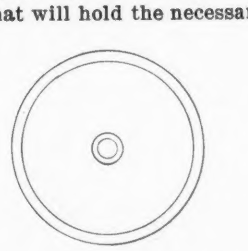
The Number of Cutting Edges.

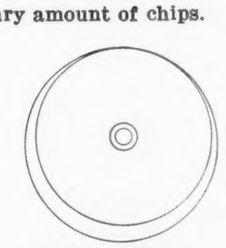
As fluted reamers are generally intended for removing but a small amount of stock, and to produce smooth holes of accurate size, it is necessary that certain rules be observed as to the number of teeth they have. It is not generally considered good practice to give such reamers less than six flutes. However, in order that the reader may know the number of teeth generally given, a table of cutting edges for fluted reamers is given.

TABLE I. CUTTING EDGES FOR FLUTED REAMERS.

$\frac{1}{8}''$ to $\frac{7}{16}''$	diameter	6 teeth.
$\frac{1}{2}''$ to $\frac{11}{16}''$	"	6 to 8 "
$\frac{3}{4}''$ to $1''$	"	8 "
$1\frac{1}{16}''$ to $1\frac{1}{2}''$	"	10 "
$1\frac{9}{16}''$ to $2\frac{1}{8}''$	"	12 "
$2\frac{1}{4}''$ to $3''$	"	14 "

It is necessary when milling reamers having the number of teeth in this table to use milling cutters made especially for the purpose, so as to obtain the correct shape of tooth and a flute that will hold the necessary amount of chips.





Industrial Press, N.Y.

Fig. 7. Fig. 8.

A mistake often made in making cutting tools is paying too little attention to the matter of chips. Stock is removed from steel, when machining, in the form of chips, and unless provision is made for these chips they are in the way. They fill the flutes of the tool, get in front of the cutting edges, and are forced into the surface of the work, tearing it and making unsightly work. Then, again, they wedge between the tool and the work, clogging it, and as a consequence the teeth are broken; or perhaps when sufficient force is applied to move it the tool is broken.

Now, to secure a tooth strong enough to stand up to the work without springing, and yet provide a flute that will take

care of the chips, special cutters are sold. The herewith table shows the number of the cutter suitable for any size reamer.

TABLE II. NUMBER OF CUTTER FOR REAMERS.

No. 1	cutter	cuts	reamers	from	$\frac{1}{8}''$ to $\frac{3}{16}''$	diameter
No. 2	"	"	"	"	$\frac{1}{4}''$ to $\frac{5}{16}''$	"
No 3	"	"	"	"	$\frac{3}{8}''$ to $\frac{7}{16}''$	"
No. 4	"	"	"	"	$\frac{1}{2}''$ to $\frac{11}{16}''$	"
No. 5	"	"	"	"	$\frac{3}{4}''$ to $1''$	"
No. 6	"	"	"	"	$1\frac{1}{16}''$ to $1\frac{1}{2}''$	"
No. 7	"	"	"	"	$1\frac{9}{16}''$ to $2\frac{1}{8}''$	"
No. 8	"	"	"	"	$2\frac{1}{4}''$ to $3''$	"

It was formerly considered necessary, to avoid chattering, to mill an odd number of flutes in reamers. The writer remembers the first reamer of this style that he was given to make. It was impressed on his mind that it was almost a crime to make a fluted reamer with an even number of teeth. It has, however, been settled beyond the shadow of a doubt that an even number of teeth *unevenly* spaced gives as good results as an odd number. And such reamers are much easier to make, on account of the ease of gaging as to size when grinding. The teeth being opposite each other, can be gaged by a micrometer caliper, while it is necessary to gage those having an uneven number of teeth with a *ring gage* of the correct size, which is not only costly, but the liability of getting the centers out of line, or a particle of emery dust in the center holes while gaging, is very annoying. Should any dust get into the countersunk hole, as mentioned, it will, of course, cause the article to run out of true. In many cases the operator will grind the piece before noticing the trouble, and when a piece of work is nearly to size a very small particle of dirt of any character will cause it to run out enough to spoil it if touched with a revolving emery wheel.

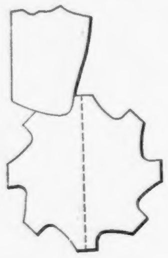
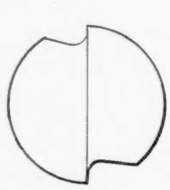


Fig. 9.



Industrial Press, N.Y.

Fig. 10.

Fig. 9 shows a form of cutter made especially for milling the flutes in reamers. The number of the cutter to use for each size of reamer is given in Table II. This form of cutter makes a tooth that is strong enough to cut and not spring, and the flute is of proper size to take care of the chips removed.

The cutter should be set so as to cut the face of the tooth somewhat ahead of the center, as shown in Fig. 9. This is known as a negative rake; the amount should be about 5 degrees. Generally speaking, a reamer will cut smoother if the cutting edge of the tooth has a negative rake—rather than radial—that is, running toward the center, as shown in Fig. 10.

It has been ascertained by experiment that when the form of milling machine cutter shown is used in milling the flutes, the depth of the cut can be accurately determined. It should be of a depth that will make the land one-fifth the average distance from the face of one tooth to that of the next. Should it not be as deep there will not be room in the grooves to hold the chips; should it be deeper, the teeth will not be sufficiently strong, and will spring out into the stock being cut, producing a very unsatisfactory hole which will in all probability be larger than the reamer.

When the piece of work has been milled square on the wrench end, and is ready to have the grooves milled, the cutter is located so as to give the face of the tooth a negative rake, as described. As stated, we can give it an even number of teeth provided they are unevenly spaced, yet in order that the size may be handily calipered when grinding, the teeth must be diametrically opposite each other. The irregularity of spacing must occur between teeth adjoining (next to) each other. To accomplish this we cut one tooth, then turn the index head of the milling machine one-half revolution and cut the opposite tooth.

For the benefit of any who may not be familiar with the working of the index head used on the universal milling machine we will say it is so constructed that it is necessary to give the index pin arm 40 revolutions in order that the work held between the center may make one revolution; of course it is necessary to put the pin in the hole we started from. To turn the reamer one-half way round we would turn the index pin twenty revolutions. Having cut the first pair of flutes—opposite each other—we turn the index head to bring the reamer in position for the next tooth. As previously stated, it is best to cut the teeth so they will be *unevenly* spaced; the irregularity of spacing is obtained by moving the index pin a greater or less number of holes than would produce evenly-spaced teeth. It is generally considered good practice to have a variation of about 3 degrees from an angle corresponding to regular spacing; it is not necessary that it be just 3 degrees—anywhere from 2 degrees to 4 degrees will answer.

In order to produce a variation of a few degrees from even spacing it is necessary to calculate the number of holes necessary to move the index pin for each move, so as to produce an unevenness of spacing that shall vary at least two degrees and not more than four degrees from an amount equal to even spacing; and as an explanation of this would cover more ground than should be taken up in this article we will consider this in our next.

* * *

THE EUCALYPTUS TREE AS AN INEXHAUSTIBLE SOURCE OF FUEL.

In 1882 Mr. Hutchins and Sir A. Brandis, as the result of their experiments, discovered that eucalypts planted on tropical mountains produce fuel at the rate of 20 tons—dry weight at 60 pounds per cubic foot—per acre per year in perpetuity. The eucalypt plantation reproduces itself when cut without further expense, and its dry timber, heavier than coal, has an equal or a higher thermal power, bulk for bulk, than coal. This result was obtained as a measurement of the maximum yield of the Eucalyptus on the Nilgiris, southern India. If a chance tree on a chance mountain in a chance soil can produce the equivalent of 20 tons of coal per acre per year, it seems not unreasonable to suppose, as Mr. Hutchins suggests, that by selection double this, or 40 tons, can be produced. A powerful sun, a heavy rainfall, and a very rapid forced growth are the essentials of such a production of wood fuel. A glance over the rainfall map of the world shows these conditions are fulfilled over about 8,000,000,000 acres of its surface, which is between one-fourth and one-fifth of the total land surface of 35,200,000,000 acres. One half of this area under forest might thus yield the equivalent of 160,000,000,000 tons of coal yearly, which is more than 288 times the world's present consumption of coal, assuming that coal and eucalypt timber are of approximately equal heating power. On the basis of the actual forest yield of the present day, we have half of this, or the equivalent of 80,500,000,000 tons. In Germany, one-fourth of the total area is under forest, and taking the German standard of one-fourth forest, on the basis of the present maximum yield we should obtain 40,250,000,000 tons; while if the maximum forest yield be converted to an average forest yield there would still remain a yearly product of 20,175,000,000 tons, which is rather more than thirty times the world's present consumption of coal. Thus it is seen that the yield of firewood from the world's tropical and extra-tropical forests, wherever they are fully stocked and scientifically worked, will yield the equivalent of from 30 to 122 times the present consumption of coal, or even up to 243 times that consumption, if the present timber yield be doubled by cultivation.—*Journal of the Franklin Institute.*

* * *

Mechanics are familiar with the hand drills, screw drivers, etc., which have a long spindle, spirally threaded, on which is a nut of peculiar construction that can be moved back and forth, to drive the tool at a rapid speed of rotation. Mechanics who are also sportsmen will be interested to know that the device has been applied to the handles of fly rods, for operating the reels. A sleeve slides on the outside of the rod handle and operates the spiral spindle, which is inside, through a slot in the handle. Bevel gears, with ratchet, connect the spindle with the reel. The inventors are Allen E. Hall and William G. Smith, of Philadelphia, Pa.

MACHINE SHOP EQUIPMENT.—4.

EQUIPMENT OF THE PATTERN SHOP AND PATTERN STORAGE ROOM.

OSCAR E. PERRIGO.

Next to the drawing room in the usual order of the production of new machines, and the development of new plans and ideas into their practical form for commercial purposes, comes the pattern shop, with its proper equipment of woodworking machines, its work benches for the expert workmen, and the conveniences for those associated with them in getting out dimension lumber, and other similar work in connection with it; and closely allied with this department, and really forming a part of it, the pattern storage room, wherein patterns may be properly catalogued, stored and issued to the foundry as occasion may require.

In the pattern shop proper the designs of the draftsmen are first brought into tangible form, as patterns for the production of those parts to be made of that most common of all materials used in modern construction, namely, cast iron, as well as those for brass, malleable iron and steel castings.

ing that the arrangement is in force of having special men for special work, there may be fourteen men as its regular force. These will be divided as follows, namely, one foreman, six regular pattern makers, one man at the lathes, one man at the planers, one man for the rip saw and the cutting-off saw, one man at the band saw and for building up segment work, one man at the varnish bench for varnishing patterns, and one man to letter and keep a record of patterns, and one general laborer.

If the product of the shop is in a regular line where nearly the same work is turned out year after year, we have only to provide for the necessary changes of patterns due to the usual changes of form and style that may be required by the demands of trade. In this case the force above provided for could well be considerably reduced. If the product of the establishment is of such a nature that improvements, both in the work turned out and also in the tools necessary to accomplish that result are constantly in progress, the force above specified will not be too great. If the product is such that a majority of the orders are for such machines as have to be made special, or with important features specialized

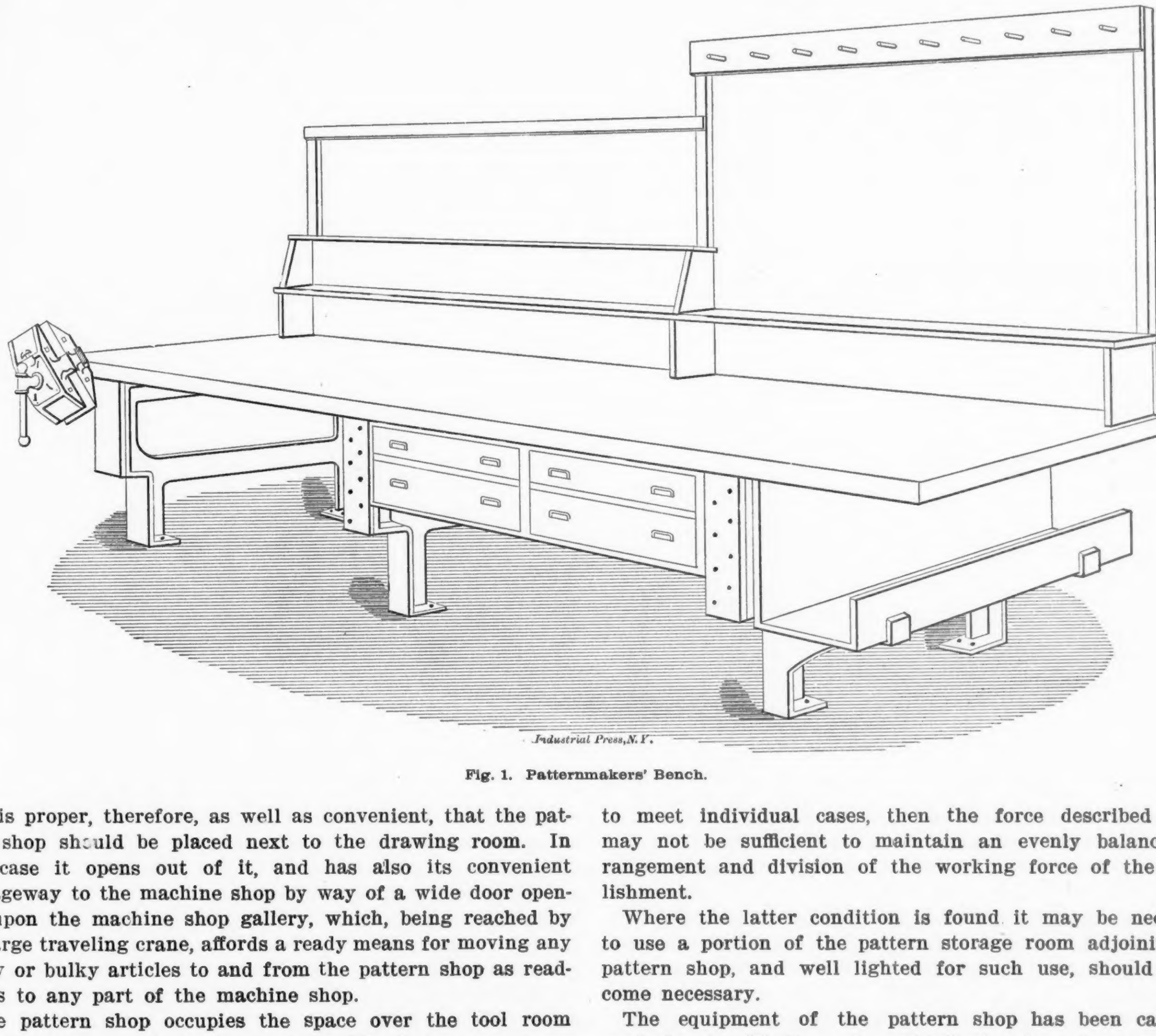


Fig. 1. Patternmakers' Bench.

It is proper, therefore, as well as convenient, that the pattern shop should be placed next to the drawing room. In this case it opens out of it, and has also its convenient passageway to the machine shop by way of a wide door opening upon the machine shop gallery, which, being reached by the large traveling crane, affords a ready means for moving any heavy or bulky articles to and from the pattern shop as readily as to any part of the machine shop.

The pattern shop occupies the space over the tool room and store room portions of one of the fifty foot square structures, and extends, also, over the space taken up by the main driveway on the ground floor. It is thus fifty by seventy feet, affording ample space for all the ordinary uses of this department.

In Fig. 2 is shown the plan of the pattern shop and the pattern storage room, and the location of the tools, machines, benches and other fixtures therein, as well as those in the pattern storage room, giving the location of the pattern storage racks, and the trap doors, one of which opens over the storage space in the yard and the other over the flask room of the foundry.

As to the capacity of the pattern shop and the number of workmen who may be employed in it to advantage, assum-

to meet individual cases, then the force described above may not be sufficient to maintain an evenly balanced arrangement and division of the working force of the establishment.

Where the latter condition is found it may be necessary to use a portion of the pattern storage room adjoining the pattern shop, and well lighted for such use, should it become necessary.

The equipment of the pattern shop has been carefully worked out, with the end constantly in view of so arranging the available space and of so equipping it with such woodworking machinery as may be necessary to carry out the plan of keeping the skilled pattern makers constantly at work on that which is essentially pattern work, and requiring a man skilled in that vocation, rather than of allowing them to use their time in getting out dimension lumber, varnishing patterns, and similar work, which may be just as well done by men of less ability and a lower rate of wages.

Consequently the machines, such as surface planer, jointer, rip saw, cutting-off saw, etc., are handled by men who are practically "mill men" who, while they know little or nothing about pattern making, are capable of getting out such dimen-

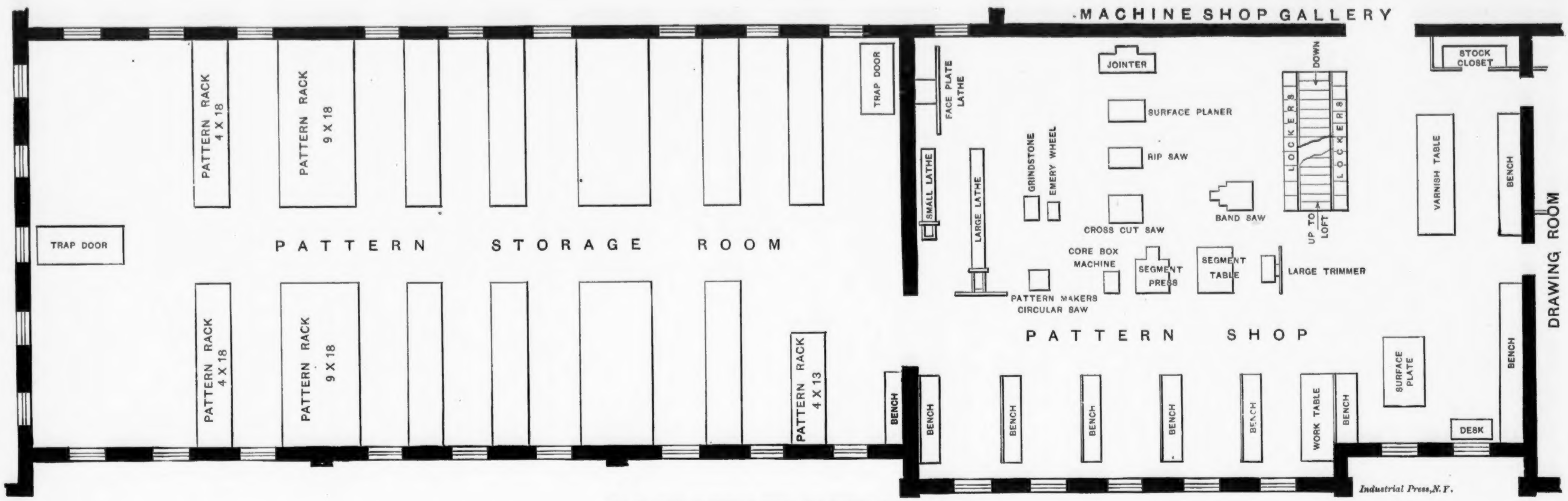


Fig. 2. Plan of Pattern Shop and Pattern Storage Room.

sion lumber as may be called for by the pattern makers in much less time and at less cost than if it were done by the pattern maker himself. So it is with the man who handles the band saw, whose principal work is that of cutting out segments for the building up of the rims of wheels, gears, etc. Being constantly at this particular kind of work, the man need not be a skilled pattern maker and yet can exceed one in the output and the economy of doing this class of work. In the same manner for varnishing of new patterns and the revarnishing of old ones, a pattern maker is not needed. Neither is it necessary to employ one to mark, letter, arrange and catalogue the patterns when completed, as this work may be just as well and much more economically done by a special man at a less rate of wages.

The equipment of machinery and fixtures for the pattern shop, and the location selected for them to insure convenience of their operation and of the handling of stock and product without unnecessary labor, is fully shown in the general plan in Fig. 2, and is as follows: Next to the machine shop wall is placed a jointing planer, provided with the usual guides and gages by which the various angles or bevels may be cut upon any length of stock up to sixteen feet. Beside this is an ordinary surfacing planer capable of taking in twenty-four inches in width and, also, sixteen feet in length. Upon the jointing planer stuff may be planed "out-of-wind," and then passed to the surfacing planer for reducing it to an even thickness. If much large work is to be made where large and perfectly true surfaces are necessary to be obtained, it will be advisable to have a Daniels, or vertical planer, to which this stuff is first taken. From the surface planer the stuff passes to the rip saw, and from there to the cutting-off or cross-cut saw. In many cases it must be passed back to the jointer to be finished on the edges.

Shop trucks with proper racks should be provided, upon which the lumber may be placed, so that unnecessary handling or carrying may be avoided.

Next to the segment press is a core-box machine, which is a very convenient, if not almost indispensable, machine where many boxes for round cores are to be made, as it accomplishes the work in a fraction of the time required to do it by hand.

Next to the core-box machine is a special pattern maker's circular saw bench, which is so arranged as to carry both rip saw and cutting-off saw, either of which may be brought into use as needed; and a table capable of being set at any desirable angle. The table is provided with guides and gages for cutting any angle wanted. This saw is of special value in pattern-shop work, and saves much hand labor, even in cutting out the quite small parts of patterns. The Colburn universal saw table is an excellent example of this class of machine.

As a large part of pattern making often consists in laying up segment work, special provision is made for it. From the planers the stuff is taken to the segment table, laid out, then to the band saw where it is cut into segments, from whence it goes to the trimmer, the ends are cut and the segments are fitted into circles on a wooden faceplate. This plate has formed on its under side a recess which fits over the iron faceplate of the lathe. A circle of these segments having been fitted together, they are glued at the ends and small steel dogs inserted to hold them. Another circle is formed and glued at the ends and to the first segment, the dogs being placed in the edges, out of the way, and the whole placed in the segment press, which holds it firmly until the glue has set; and so on until the job has been completely laid up. It is convenient to have two faceplates to work on alternately, as one may be in the press while an additional circle of segments is being fitted to the other. The segment press is of the vertical type, and may be constructed with a large screw acting upon a follower, or it may be built similar to a Greenerd arbor press with a rack and pinion arrangement. A convenient form is one with a vertical screw having fixed to its upper

end a large wormwheel which engages a worm upon a horizontal shaft, which extends to one side of the press, where a handwheel is attached to it for convenience of operating. With this arrangement segments may be made and laid up in much less time than where hand clamps are used and applied as each segment is laid on, while the evenly distributed pressure insures good contact of all the pieces. They may be nailed, or not, as desired.

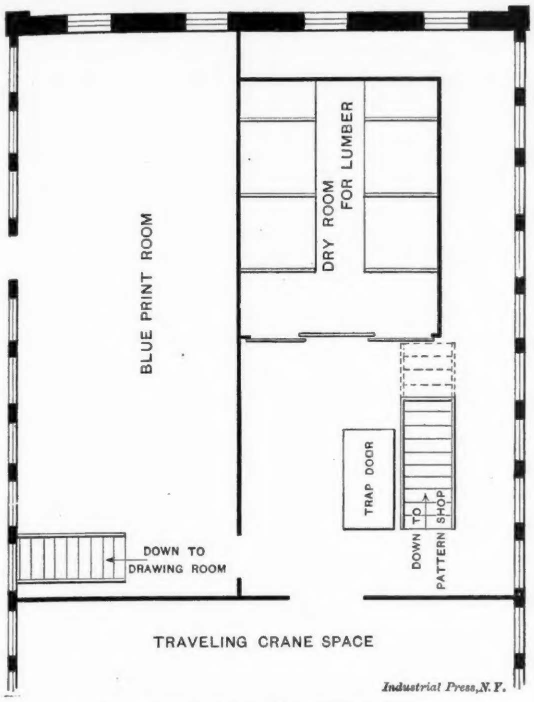


Fig 3. Plan of Loft over Pattern Shop.

For small turned work a wood lathe to swing eighteen inches, and with a ten-foot bed, is provided. For larger work a lathe of thirty inches swing and with a sixteen-foot bed will be a good size. Both should be provided with slide rests, and the larger one with a faceplate on the back end of the spindle for turning large work from a floor rest. When much larger faceplate work is called for, a faceplate head is needed, and one is located near the rear wall and in line with a rear window. This head carries a faceplate capable of swinging ten feet. In front of this, may be arranged a compound rest,

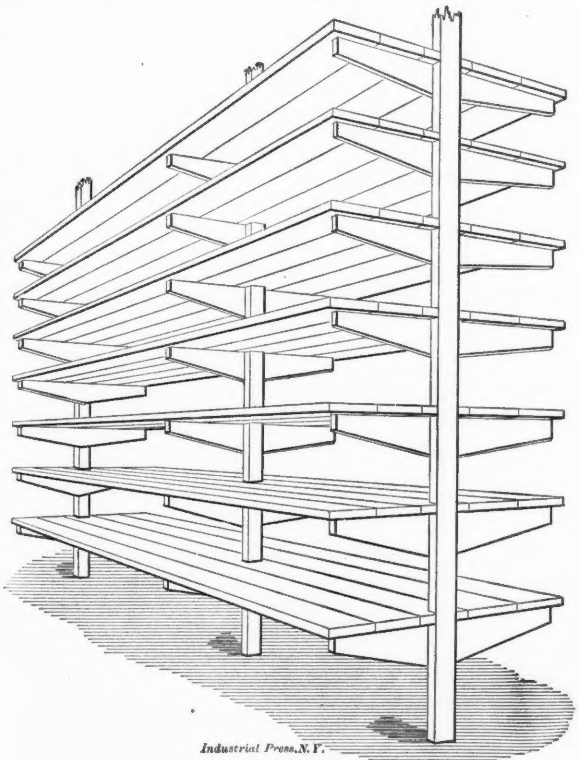


Fig. 4. Pattern Rack.

supported by a pedestal, and capable of covering the turning, inside and out, and of facing the largest work to be done.

Near the lathes the grindstone and the emery wheel are located. The latter should be provided with wheels of different form for grinding the various shapes and sizes of gouges and similar tools in use.

The foreman's corner is next to the drawing room, so as to be in convenient communication with that department. He has a bench, more as an occasional convenience than for regular use, and a desk, as a necessary part of his equipment.

The first pattern maker from him has, in addition to the regular equipment, the use of a cast-iron surface plate, say five by eight feet, its dimensions regulated, of course, by the kind of work to be done. This is an indispensable convenience in building up many of the more complicated patterns, and there should be at least one in every pattern shop.

The pattern maker's bench is shown in perspective in Fig. 1. The top is thirty inches wide and ten feet long. It stands thirty-four inches high. It is composed of hard maple at the front, twelve inches wide, and the rear portion of white pine, both two and a half inches thick. It is supported on three cast-iron bench legs, the front feet of which are set back five or six inches, so as to be out of the way of the pattern maker's feet. The upper sixteen inches of these legs has a facing of hard maple, that on the center and rear legs having holes for the introduction of pins for supporting long work when held on edge. Four drawers, with flush pulls, are placed in a case under the rear portion of the bench, for holding small tools, files and a variety of similar articles found necessary by every pattern maker. At the rear end is formed a compartment under the bench for holding short pieces of hardwood stock, dowel pins and similar materials. At the head of the bench is located an Emmert universal vise, which seems to be the best device yet put on the market for this purpose, as it may be placed in almost any position convenient to the workman, and will hold a piece of almost any form with equal facility. At the back of the bench is a shelf or tool rack extending the whole length, and at a proper height above it is one extending one half the length. These are to be properly perforated for the reception of the ordinary tools of the pattern maker, such as his chisels, gouges, auger bits, twist bits and drills, screw drivers, and all similar tools. Over this short tool rack the backboard is extended up to a light rail, so as to provide a space for hanging larger tools, such as bit-stocks, back saws, and tools of this nature. At the back of the rear half is an open frame whose top bar is

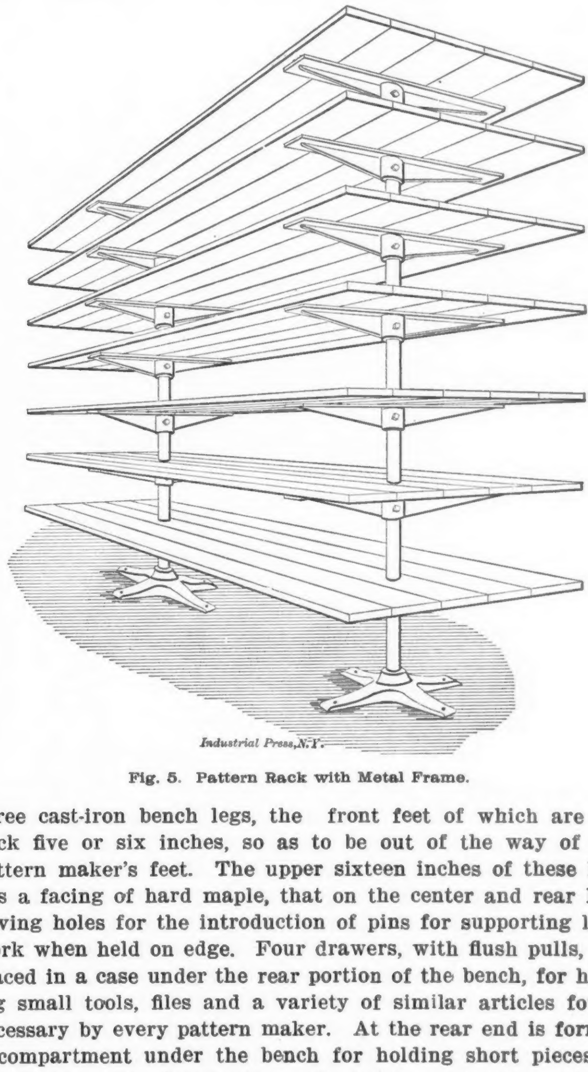


Fig. 5. Pattern Rack with Metal Frame.

provided with pins for hanging large saws and similar articles. If the kind of work renders it necessary a bench trimmer should be attached at the rear end. This style of a bench is at once rigid and substantial, does not occupy unnecessary floor space, is compact and complete in all its arrangements, and for a first-class bench it is economical in cost.

These benches are arranged with the head toward the wall and two feet from it, so that private tool boxes or cupboards may be conveniently arranged upon it. Their positions are clearly shown in the plan.

A large work table is provided for the second pattern maker, and one should be provided for the others when the nature of their work requires it. It may be placed either between the benches, or near their rear end, as may be most convenient.

It will be noticed that the benches and machines are so arranged that they leave a broad alley through the shop, and to the door leading to the machine shop gallery.

There is a regular wall bench and a large center table provided for the varnisher and the workman having charge of the marking, numbering and cataloguing of the patterns. From this point they may be taken on properly-arranged platform trucks, to the pattern storage room, or to the foundry, as the case may require.

At each side of the stairs leading to the loft the individual lockers for the use of the men are arranged. These are of the expanded metal type, as built by Merritt & Co., or of some very similar material and construction, but never of boards, or any construction which excludes thorough ventilation and safety from fire.

The stairs just mentioned lead to the loft shown in the plan in Fig. 3 and in which is constructed a lumber drying room, as laid out in the plan and shown in interior perspective in Fig. 6. This room is tightly closed by double sheathing on the top, the back and both sides. The front is closed by three sliding doors, arranged to pass each other, so that any portion of the front may be opened for the purpose of putting in or taking out lumber. The lumber racks are of wood construction, the posts being 4 x 5 inches, the two lower horizontal timbers 3 x 6 inches; the next two are 3 x 5 inches, and the upper three are 3 x 4 inches. These timbers should be firmly bolted together and to the sides of the room by through and through bolts as there will necessarily be much shrinking of the timbers, and consequently no nails should be used. The sheathing may be put on vertically or horizontally, as preferred, but both thicknesses should run the same direction, and should break joints. The studding or timber work supporting the sheathing should not be over three feet apart, in the direction of the length of the sheathing.

In the drawing, Fig. 6, only the front frame is shown on the left of the room, to avoid a confusion of lines, as the form and location is fully shown on the opposite side. The frames should be placed seven feet apart, so as to accommodate lumber from eight to eighteen feet in length. The lumber is placed on edge, supported by three racks, or frames of this kind and held in place by round iron rods, five-eighths inch for the three lower sections, and one-half inch for the three upper sections. These rods should be placed five inches apart in the lower section, four inches in the second, three and one-quarter inches in the third, two and one-quarter inches in the fourth, one and three-quarter inches in the fifth, and one inch in the sixth, from center to center. The distance apart, in the clear, for the horizontal supports, should be eighteen inches for the lower four spaces, and sixteen inches for the upper two spaces, if lumber of the ordinary widths is to be used.

Heat may be applied by a steam coil as shown in Fig. 6, or hot air may be admitted from the regular air pipes of the heating system. The degree of heat should not be high as the seasoning process is apt to be too much hurried and so produce an unnecessary number of "season checks" by drying and consequently shrinking the outer portion of the lumber before the center has the opportunity to contract with it. Some have advocated the plan of standing the lumber on end, and then turning it "end for end" once a week. This causes an unnecessary amount of labor. If the lumber is placed in the racks as shown, it will not be necessary to even turn it over, provided too high a temperature is not maintained. The necessity for a dry room is apparent from the fact that it is very difficult to obtain properly kiln-dried lumber fit to put into pattern work, whatever price we are willing to pay for it. And unless we dry it ourselves we are never sure of its condition. Patterns are too expensive to take any chances of improperly seasoned lumber.

For convenience in passing lumber to and from the dry room, a trap door, as shown in Fig. 3, may be made in the floor of the loft. Pattern lumber may be delivered on the machine shop floor, passed to the gallery by the traveling crane, then up through this trap door to the dry room. After it is properly dried, it may be passed back to the pattern shop in the same way. Or, it may be passed in through the trap door over the pig iron storage space, and thence into the pattern shop.

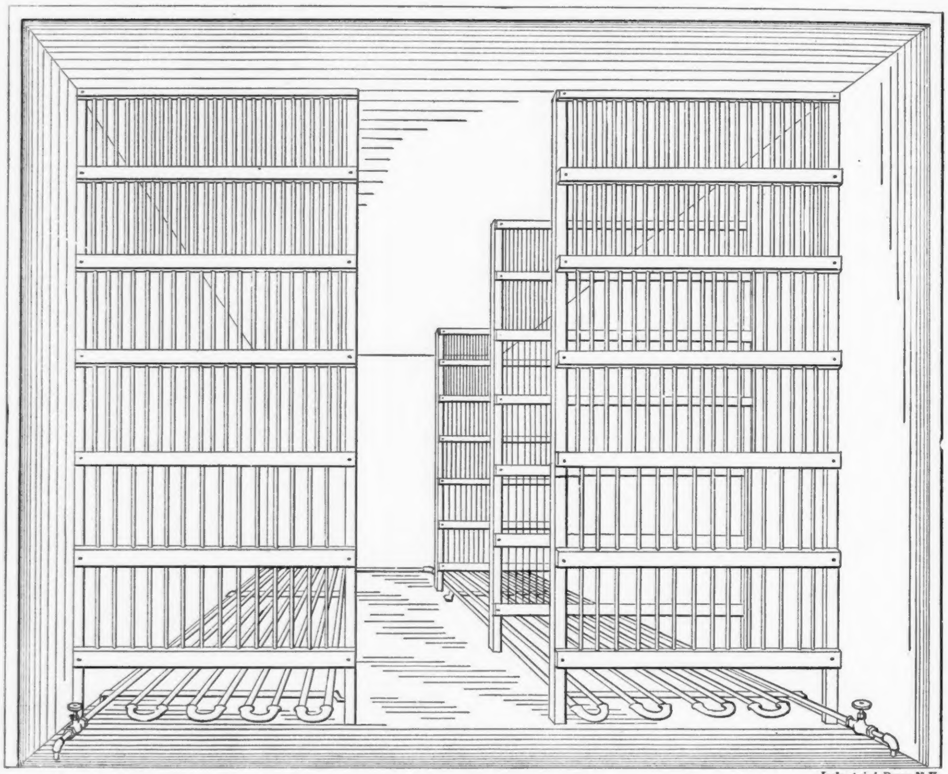


Fig. 6. Dry Room for Lumber.

The pattern storage room is a continuation of the pattern shop, a door eight feet wide giving ample access to it. In the inner corner, next to the pattern shop, is a trap door four feet by eight, opening over the pig iron storage space, and at the other end of the room is a trap door four by ten feet, opening over the flask room of the foundry. Over this trap door is a quick-acting hoist by which patterns may be readily lowered to the foundry, or brought back to the pattern storage room. This room is amply lighted so that patterns may be easily found, stored, or taken from the shelves as needed.

The system of storing patterns is upon a series of shelves arranged so as to form alcoves connecting with a wide passage way in the center, the pattern racks being placed with the end against the wall, and regularly between the windows. Opposite the broad spaces in the walls where the pilasters are

located, and space between windows is wider, the pattern racks are made of double width, and are used for the storage of larger patterns, which may be more conveniently stored on very broad shelves. Should the patterns be generally of small size, so as to make narrower shelves advisable, the racks may be all made of single width and located without regard to the windows. In this case they are placed two feet from the wall. In the arrangement shown, the single racks have shelves four by eighteen feet, and in the double racks the shelves are nine by eighteen feet. Thus, the latter style will accommodate from four to nine feet in length.

At the end of the pattern storage room next to the foundry, a space is left clear for the care and storage of patterns too large for placing upon the shelves. It will, of course, be understood that in every shop special arrangements must be made for the care of patterns peculiar to the kind of work done, and that the arrangement here given is only such as may be useful in a general way, and that it is subject to whatever modification may be necessary to suit individual conditions. For instance, if there are many heavy patterns like lathe beds, planer beds, or engine beds, etc., it will be necessary to provide a larger space for them, and also, to arrange for readily lifting and moving them. A convenient method is to suspend an I-beam overhead, and upon this to run a trolley with a chain or rope hoist, by means of which the patterns can be picked up and moved wherever they are wanted. These may be put up with branches and switches, so as to cover any desired space. If these large patterns are placed entirely upon the floor they will occupy too much valuable space. They may be arranged in this manner: One bed pattern may lie upon strips not less than an inch thick laid on the floor. Over this pattern are placed two or more trestles, high enough to clear it. Upon these a second pattern may be placed. Over this place still higher trestles, and upon them support a third pattern, and so on. The advantage of this method is that the patterns may be always kept in good condition and "out-of-wind," while if, as is often done, strips are laid upon one pattern, and another pattern supported upon it, there is a strong probability that it will be marred and injured, or warped out of shape.

Various forms of racks, both self-supporting and attached to the building, have been devised. The common form used to be that of supporting the shelves by a series of posts placed four to eight feet apart, and spiking to these horizontal strips, upon which the boards or planks forming the shelves were placed. Frequently a strip three or four inches high was placed around the shelves to prevent the patterns from falling off. This made a receptacle for dust and dirt which was not only disagreeable but difficult to get rid of. In this form of racks the numerous uprights obscured a good deal of light, and were very much in the way of conveniently handling patterns.

Considering these conditions, the best arrangement of pattern racks seems to be of the forms shown in Fig. 4 and Fig. 5. The form shown in Fig. 5 is composed of two heavy cast-iron bases, into which are screwed pieces of three-inch wrought iron pipe. Upon these are fitted cross supports of cast iron with rough-cored holes. They are held at any desired height by two setscrews in each support. Upon these supports the shelves are built, their thickness being according to the weights of patterns to be stored. For ordinary patterns the shelves should be of one and a quarter inch planks, and the distance between supports not over eight feet. Where heavy patterns are to be placed on the shelves the planks should be one and a half inches thick, and the distance between supports reduced to about six feet. In this case setscrews should not be depended upon to hold the cross supports in place. Pieces of wrought iron pipe, large enough to easily slip over the upright supporting pipes, and cut the exact length necessary, should be used, by first placing one over the pipe and resting on the cast-iron base. Then put on the cross support, then another piece of pipe, and so on to the top. The planks are fastened with heavy wood screws passing up through the cross supports. The bases should be fastened to the floor with lag screws.

If inconvenient to construct these tracks with iron supports as just described, they may be constructed entirely of wood. If this is to be done the uprights are fastened to the floor and also to the overhead timbers by nailing, or still better, by iron knees and wood screws, so as to be held firmly in their proper position, as shown in Fig. 4. To these uprights are spiked cross pieces or supports of the form shown, and upon these are laid plank shelves as described for the shelves when iron supports are used. If the patterns are very heavy, the cross supports may be let into recesses in the uprights, and fastened with through and through bolts. The proper distance between supports will be the same as with the iron construction of supports. For ordinary and usual conditions the vertical distances will be about as follows: From the floor to the top of the first shelf, two feet; from the top of the first shelf to the top of the second, twenty-two inches; to the next, eighteen inches; to the next, sixteen inches; to the next, fourteen inches; and to the top, twelve inches. Of course these shelves may be continued higher up than this, but on account of the difficulty of access the above arrangement would seem to be quite high enough.

Several light step ladders should be provided for conveniently reaching the patterns on the upper shelves. Obviously, the heavier patterns will be placed on the lower shelves. Large gears, pulleys, balance wheels, etc., may be set on edge, in racks similar to those used for holding rolls of belting, but are somewhat more liable to become warped than if they are laid down flat on the shelves that are true and level.

In the case of the double width shelves, as called for in the plan, Fig. 2, there should be two upright pieces of wrought iron pipe to carry the cross supports, the latter being made of appropriate form, and having cored in it two holes, four feet apart, from center to center. A similar modification should be made in the wooden construction. For racks of eighteen feet in length there should be three supports, the outer ones placed thirty inches from the ends, and the third one in the center. This will provide for three wrought iron pipe supports in a rack four feet by eighteen feet, and for six supports to a rack that is nine feet by eighteen feet.

One of the greatest conveniences of this system of shelves for storing patterns, is the fact that they are free of access on all sides, with absolutely no obstruction whatever, either to light or the handling of patterns, while their appearance is much better than any of the older forms.

* * *

Some British economists have deplored the exportation of coal from the British Isles, claiming that in so doing they are living on their capital, inasmuch as coal *in situ* is regarded by them as capital. In an editorial on fiscal fallacies the *Colliery Guardian* says that if coal *in situ* is regarded as capital, it is destroyed equally as much if burned at home as though it was exported. If burned at home and the resulting product is exported, the result is exactly the same so far as future generations and the coal supply are concerned, as though the coal had been exported. It is, however, regarded as a fallacy by the *Colliery Guardian* to hold that coal *in situ* is capital; "it can only become capital by utilizing it." Another writer quoted says that "to sit on the lid of our grimy treasure chest until some Edison of the future has rendered its contents valueless, would be a foolish proceeding." From which we infer that while "you cannot eat your cake and have it too," by eating it, ways and means are made by which two cakes can be obtained for the next meal. Miserly saving does not create wealth, it only conserves it; consumption that stimulates a healthy supply does create commerce, wealth, inventions, manufactures and the other attendants of advanced civilization.

* * *

In the description of the new Springfield army rifle, published in the October issue, it was stated that the height of the maximum ordinate of the trajectory shooting at a range of 1,000 yards, is only 20.67 *inches*—a most wonderful result! This should obviously be corrected to read 20.67 feet, which makes it agree with the figures given in the table. The mistake could not have deceived anyone acquainted with the elements of gunnery and the laws of mechanics, but it is an example of the provoking errors that will creep into printed descriptive matter in spite of the most careful scrutiny. The range for a trajectory 20.67 inches high, shooting with this rifle, is about 1,000 feet.

BREECH MECHANISM OF THE 16-INCH COAST DEFENSE GUN.

Much interest, naturally, has been taken by the public in the great 16-inch seacoast defense gun, model 1895, which was recently completed at Watervliet Arsenal after a period of nearly nine years had elapsed since the contract for the great lathe and other machinery was made with the Pond Machine Tool Co. in 1894. Since the completion of the gun it has been transported to Sandy Hook Proving Ground, and has successfully passed the test to which all ordnance is subjected before being permanently mounted.

The 16-inch gun is the most powerful ever built, its 2,370-pound projectile with the normal powder charge (640 pounds of smokeless nitro-cellulose), velocity 2,300 feet per second, having a muzzle striking energy of over 88,000 foot-tons, but there are some doubts as to its practical utility in actual warfare. Nevertheless it is a triumph of design and mechanical construction; so far it is the largest gun built by the modern system of shrinking jackets and hoops upon a tube, giving the latter an initial compression nearly equal to its elastic limit. By this construction the initial compression must be overcome before there is any tendency to burst the tube. Partial details of construction, principal dimensions and other data may be found in MACHINERY for September, 1901, and May, 1902. The following matter has reference to the breech action which is presented as an interesting example of mechanism—not new, of course, but of interest to many readers nevertheless.

Fig. 1 shows the gun as it now appears on the temporary mounting where the proving charges were fired. The permanent mounting will be on Romer Shoal, a chain of rocks lying between Sandy Hook and the western end of Long Island. Just beyond it is the Gathmann 18-inch gun, which, however, is not nearly so heavy, and some distance beyond that is the Brown wire-wound gun which in a recent test fired a shot with an initial velocity of 2,500 feet per second. A government railway runs the length of the "Hook," and the temporary mountings are all located close to it. Further along the track towards the point of the "Hook" is the regular proving ground where the standard types of seacoast guns and mortars are proved.

The breech actuating mechanism of the 16-inch gun is known as the Stockett system, which does not differ greatly from the Farcot-Fletcher system used on the 10 and 12-inch guns, being a modification of same. It is an example of a simple mechanism which performs a somewhat complicated action by simply turning one crank. The views, Figs. 2 to 11 inclusive, show it in the closed and open positions, and in three intermediate positions. Two views are shown in each case, one from the rear and the other at an angle of about 45 degrees.

As stated, only one crank is used to open and close the breech. The action is continuous and entirely automatic in the matter of changing from one motion of the breech-block to another, there being three distinct movements of the block in all.

With the breech closed, turning the crank to the right first rotates the breech-block 30 degrees, or one-twelfth of a turn. This movement disengages the threads of the interrupted screw, there being six sectors threaded and six blank, each 30 degrees wide. To be exact, the width of the threaded sectors in the block is 0.05 inch less than 30 degrees of the total circumference, in order to give the necessary clearance. This completes one movement. Continued turning of the crank is now converted from rotation of the breech-block into translation of same longitudinally from the breech, the interrupted thread now being so disposed as to permit this movement. It will be noticed that the worm, engaging the section of worm-wheel cut from the solid on the end of the breech-block, is also a pinion, having both longitudinal and spiral cuts. It is thus enabled to act in a double capacity—as a worm when rotating the breech-block, and as a pinion when moving it longitudinally. When the breech-block has been rotated 30 degrees, further rotation is prevented by the compound gear coming into contact with that portion of the mutilated worm-wheel or rotating rack in which no tooth space is cut, but it is now opposite the translating rack cut from the solid in its side, and of the slide way prepared for it in the tray. The last tooth of the rotating rack is cut away on the inner side to avoid interference, and the first two teeth of the translating rack are modified also. The moment the breech-block stops turning, the end-thrust upon the rotating rack initiates the longitudinal movement and brings the translating rack into action. The change from one movement to the other is accomplished without perceptible shock or jar, as the writer witnessed. The mechanism is easily operated in either direction from start to finish with one hand.

The motion of translation now begins, which is movement number two. It ejects the breech-block upon the tray, or console, which is grooved with overhanging ledges for the reception of a corresponding section planed in the block. When the block has reached the end of its prescribed travel, the ledges on the tray bring up against stops on the block, and at the same time a latch is tripped which locks the tray to the end of the breech. This latch, the end of which is shown in the middle of the end of the tray, is pivoted near its center so that when the breech-block stop abuts against the upward projecting outer end, the inner hooked end is thrown upward and disengaged from the breech hook or catch. The tray and breech-block are now free to swing on the hinge pin, and are forced to do so, through an angle of about 123 degrees. This completes movement number three and leaves the breech wide open, 22½ turns of the crank having been made. The same number of turns are required, of course, for closing the breech after loading. The hinge pin and the vertical worm shaft are one, and as the worm shaft is mounted on hardened

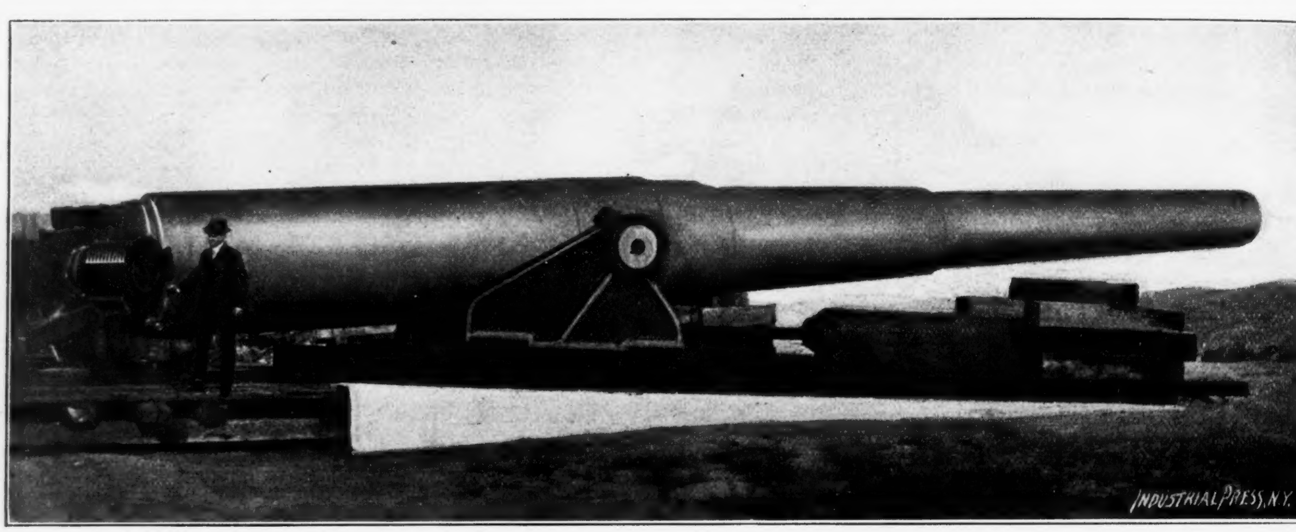
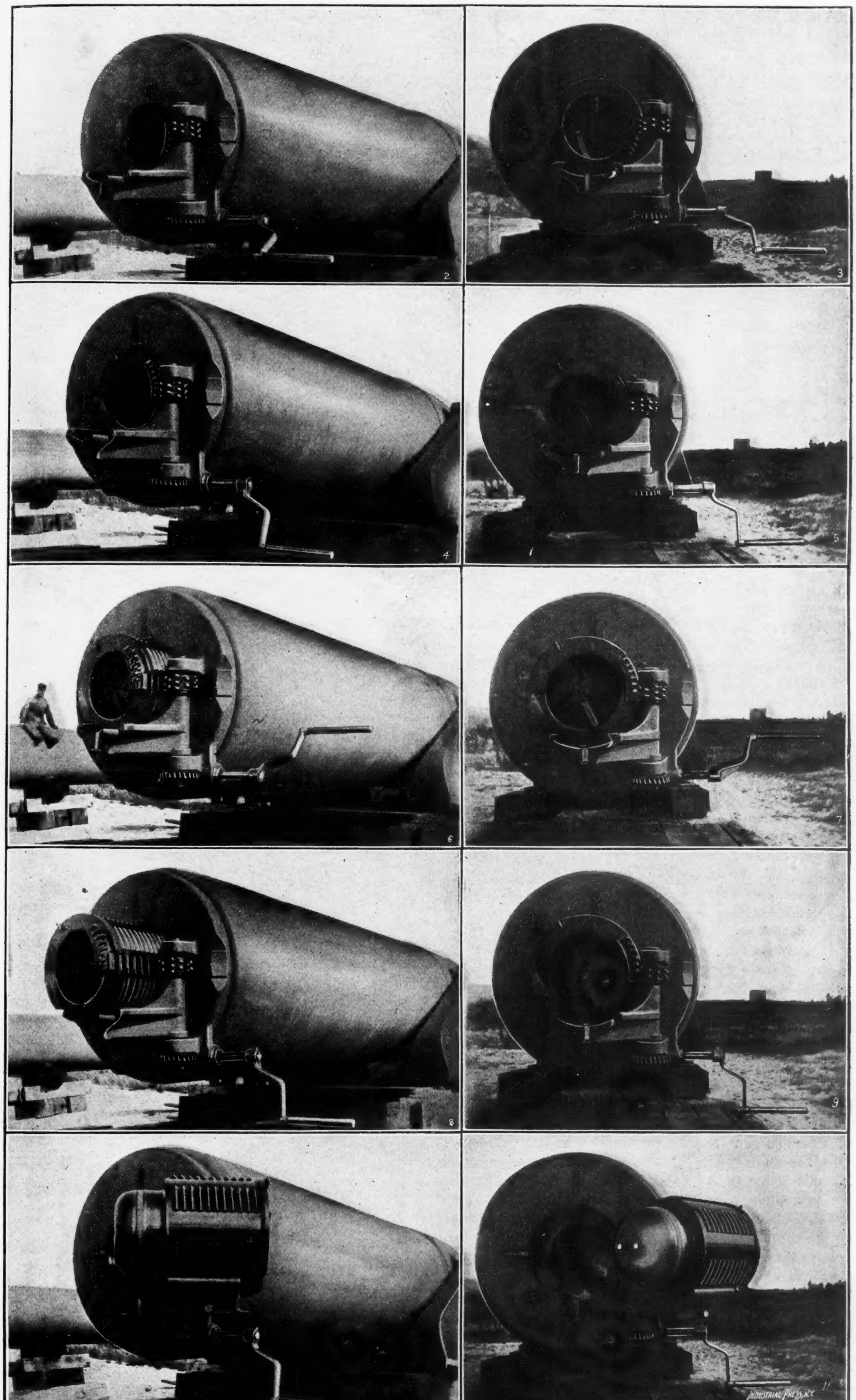


Fig. 1. Sixteen-inch Coast Defense Gun, at the Sandy Hook Proving Ground.



Figs. 2 to 11 inclusive, showing five Successive Positions of Breech-block of 16-inch Gun at Sandy Hook.

ball bearings, the frictional resistance of operating the first two movements of the block and of swinging it around on the tray, are reduced to a minimum. This partially accounts for the remarkably free and easy movement, but careful fitting is shown in every detail and this is what counts on such work.

The fermeture is of the De Bange or French type. The breech block has an outside diameter of 25.96 inches; total length 27.3 inches; diameter at root of the thread of 24.82 inches; length of threaded portion 19.89 inches. The thread is of symmetrical section, having an inclined angle of 106° 24′ and a pitch of 1.71 inches. The top and bottom of the thread are rounded, the radius of the top being 0.17 inch, and of the bottom 0.11 inch. The shape of the thread differs from that of the naval guns, which is a modified buttress section, making an angle of 15 degrees on one side with the normal to the axis, and 45 degrees with the other. The circular pitch of the wormwheel or rotating rack cut in the block, is 1.577 inch; normal pitch, 1.5 inch. The translating rack has a pitch of 2.426 inches and the depth of the teeth is 1.11 inch. The compound gear operating the block has an outside diameter of 8.685 inches and is quintuple threaded, the threads having a lead of 7.885 inches and an angle of 18 degrees. The pinion teeth for translating the block, are ten in number, circular pitch 2.426 inches, of course, to agree with the pitch of the rack.

The obturator, which appears as the rounded inner end of the breech-block in Figs. 10 and 11, is the De Bange modified type. It consists of a mushroom head having a diameter of 18.85 inches, and a spindle 6.22 inches diameter at the forward part and 5.97 inches at the rear, which passes through the block and is secured by nuts on the outer end. Between the mushroom head and the end of the block packing is interposed to act as a gas-check. When the charge is fired the pressure on the mushroom head forces the packing outward against the walls of the powder chamber and prevents the escape of the gases. To prevent sticking of the action after a discharge, the obturator spindle is made to turn freely in the block so that it may remain stationary when the latter is first being opened. But the backward motion of the block, due to the pitch of its thread, releases the pressure on the packing and loosens it so that it moves freely by the time the block is turned 30 degrees. It is obvious that if the obturator had to turn with the block a heavy twisting moment might have to be applied under some circumstances to start the action loose.

The screw heads shown on the obturator head are for holding the crusher gages which are used when proving the gun, to indicate the pressure developed in the breech chamber by the powder charge. A crusher gage consists of a short steel cylinder inclosing a cavity in which is a copper shell. A hole is bored in the cylinder and in it is fitted a small piston to receive the pressure and transmit it against the copper shell. The latter yields when the charge is fired, and the amount of the yielding or crushing is an index of the pressure.

The firing of a charge is done electrically. The primer is screwed into the small hole in the outer end of the obturator spindle, which may be seen in some of the views. This hole is 0.2 inch diameter and is drilled clear through the spindle and obturator head, terminating in the powder chamber. Circuit breakers are provided so that a charge cannot be fired unless the breech is fairly closed. These may be seen, say, in Fig. 3, one being on the upper side of the breech-block and the other in contact with it and attached to the breech plate. If the breech-block is turned ever so little from the closed position, the contacts are separated and firing cannot be effected. An additional safeguard is a safety lever which is swung over in such a position that a primer cannot be screwed into the primer hole except when the breech is closed. Figs. 3, 5, 7 and 9 show this action.

Some confusion has arisen regarding the weight of this gun, partially, perhaps, because of the practice of the Ordnance Department of expressing weights in long tons. The weight engraved on the muzzle is 284,500 pounds, equivalent to 131 long tons. The 88,000 foot-tons striking energy is in long tons also; in short tons it would be 98,500 foot-tons.

The photographs from which the cuts in the preceding description were made were taken by the associate editors of this journal, acting under permission of the Chief of Ordnance, Washington, D. C., and the commanding officer of the Sandy Hook Proving Ground. The trip from New York City was made one clear day in October last, leaving Pier 12, East River, at 10 A. M. on the Government tug the *Edna V. Crew*. No one not connected with the Government service or not having a pass is permitted to take passage on this tug, nor to land at the Sandy Hook pier. A distance of nearly twenty miles is traversed across the Upper Bay, through the Narrows, and down the Lower Bay before reaching the destination. The route is the same as that traversed by all the larger vessels entering or leaving the port and is one that gives a good idea of the immensity of New York's harbor, and of the commerce that daily plies its waters.

As the name denotes, the "Hook" is a great sand bar curving into the ocean and marking the outer limit of the Lower Bay. It is a barren, desolate spot covered with a scrubby growth of trees and bushes, undisturbed save where the Government fortifications and buildings are located. The latter are mostly wood, but are being replaced with substantial brick structures that will be a credit to the country, which cannot be said of some of the wooden ones now in use. The fortifications are of great extent and appear practically impregnable. They have been greatly improved within the past two years, and the plans are by no means yet complete. The 10-inch and 12-inch guns are of the disappearing type, mounted on Buffington-Crozier carriages behind earthworks many yards in thickness. These earthworks are faced on the inner side with very heavy concrete walls. Below the gun mounts are the magazines in chambers also built of heavy concrete. The fortifications as a whole are an interesting example of the growing use of concrete for almost all purposes where masonry was formerly employed.

The regular proving ground is located so that firing may be directed toward the sea, save when armor or targets are to be tried. Firing is directed through two wire screens forming part of the Le Boulengé chronograph used for determining the velocity of the shot. When firing out to sea the horizon is carefully watched by the commanding officer through field glasses to see that no vessel is in range. The great shots ricochet across the water in leaps one-half to a mile long, at times throwing a spray of water fully 150 feet high. The report and concussion of a 12-inch gun is not so impressive as the great flash of flame and the peculiar screech of the shell through the air. A flying shell may at times be seen when the light is just right, but it requires a good quick eye to detect it. At the moment of firing the officers and men retreat to the bomb-proofs to avoid injury in case the piece proves defective.

* * *

One of the litle niceties that go to make up a well-designed machine are the dust-proof oil-hole covers which are coming to be adopted by manufacturers of nearly all types of machines, replacing loose plugs or caps, or bare oil holes having no covers at all. These devices not only locate the oil holes for the operator, and make sure that no oil hole will be overlooked, but prevent the holes from becoming clogged, conduct the oil to the right place, keep out dust from the bearing, do not become lost, and are directly responsible for a longer life of the bearing. Such covers have been particularly applicable to machine tools, where accurate fits and alignment are necessary, and to automobiles where dust works into bearings so readily. We find, also, that builders of paper machinery, printing machinery and woodworking machinery are also utilizing covers of the same description because of the superior finish and evidence of attention to details given by such devices to their products.

* * *

Holland has not granted patents for the protection of inventors, being the only civilized country having greatly diversified manufactures which has not thus stimulated the development of new ideas. But this glaring defect is soon to be remedied, steps having been taken by the government to pass laws for the protection of inventions and trademarks.

METAL COLORING.

TREATMENT OF COPPER, BRASS, IRON AND STEEL TO PRODUCE COLOR EFFECTS.

W. J. KAUP.

This is a subject that has received but scant attention in our technical papers, which is rather surprising when we note the natural inclination of the manufacturers of to-day to combine this artistic treatment with utility, and add to the severe straight-line plainness of our commercial product contrast of color, to make it more beautiful. There is nothing new in metal coloring to-day. Ages ago it was old in Japan, and to the Orient we must really turn for original authority on successful coloring of metals. To-day we only imitate the Eastern artisans. This is true, not because we lack the skill and intelligence of the Orientals, for we know full well that the commercial metals of Japan are inferior to our own and that our knowledge of metals from a scientific standpoint far exceeds theirs. It may be that to the very fact of the inferiority of their metals is due their success in coloring, for many impure metals (by that is meant alloys, found by combining two or more metals into one) are peculiarly subject to many variations of color.

For example, copper; commercially pure copper; ordinary commercial copper; or copper castings, when treated with the same solution, will have a different shade of coloring. The most pronounced difference will be found in the copper castings, due to the zinc that is combined with the copper for the commercial reason of obtaining sound castings. In these copper castings the color will be very much darker than in the other varieties of copper.

The purpose of this article is to give to those who are interested results of a number of experiments in coloring metals, solely from the manufacturing side, rather than from the chemist's standpoint. So many conditions enter into the work that no law can be laid down by which everyone can obtain the same satisfactory results, for with everyone the coloring of metals must be more or less of an experimental nature. A cheap monochrome color can be produced by the novice who is unacquainted with the metallurgical properties of metals and chemical actions of solutions used, but the very fact that the slightest change in alloy, as well as in the strength of coloring solutions, produces a different shade of coloring under the same treatment, makes it essential that the operator should have considerable knowledge of metallurgy and chemistry for any except the simplest work.

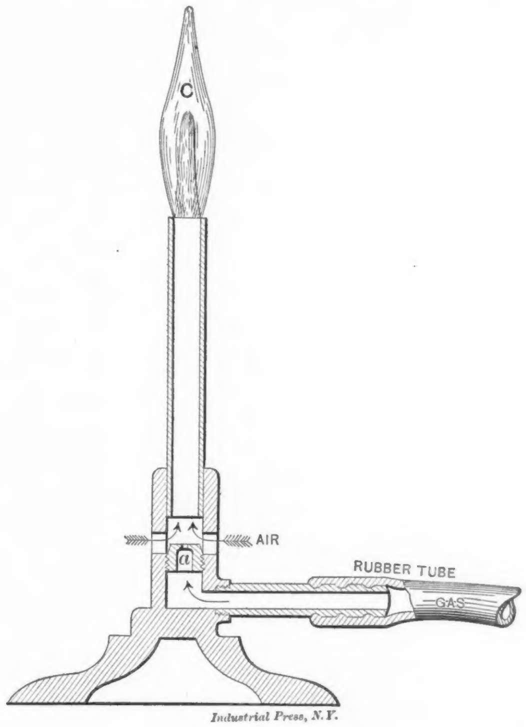
First, let us consider the different methods and conditions under which color can be obtained, viz., by heat treatment alone; varnishes and lacquers; and corroding agents or chemical compounds. We will treat each under its separate heading, but first will refer briefly to the Bunsen burner, by the use of which, together with a pot of heavy fish or lard oil and a pair of tweezers, one can color small pieces by the heat process.

Bunsen Burner.

We will take for granted that some readers, at least, are not acquainted with the Bunsen burner, or at least the principle of its operation. The cut herewith will explain its construction. The idea in this burner is to procure a flame capable of producing great heat, but which will not smoke any vessel or article, heated in it or over it, and if you will carefully note the construction it will be readily seen how this is accomplished. The force of gas, escaping through the small aperture at *a*, draws the air through the holes in the sleeve surrounding the jet. The air and gas mix together, consuming the carbon produced by the decomposing gases before it becomes incandescent, and produces the flame desired. The air is controlled by the sleeve, which turns around the inner tubes, thereby increasing or decreasing the size of the opening through which the air is drawn. A few minutes' use of the burner will enable anyone to get the flame right, but a few points in this regard may be useful. The flame should be about $2\frac{1}{2}$ inches high only. It should not blow. Should burn with blue light, showing defined inner cone of blue-green light immediately *above* which point *C*, the greatest heat is obtained.

Heat Treatment.

The work over such a burner is necessarily small, such as small screws, bolt heads, washers, pins, etc. The work should be thoroughly cleansed from all grease, either by dipping in a strong hot lye solution or alcohol, then dried in clean sawdust, for it is absolutely essential that the entire surface must present the same physical condition, to obtain uniformity of color. The work should be subjected to the flame immediately above the inner cone of light. Carefully watch the varying change of color and withdraw from the heat before it quite reaches the blue desired, hold in the air until the desired shade appears, then check by dipping in the oil and allowing it to cool in it. Very good blueing can be done in this way, by the beginner, on pieces of uniform shape, but much more skill will be required on pieces where shapes are irregular, large surfaces in one place and small in another, when the heat



Section of Bunsen Burner.

must be confined to the larger part for a longer period of time than is necessary for the small parts. In such cases the amount of heat contained in the larger part is usually sufficient to produce the desired effect after taking from the flame.

Another very common method, especially for flat work, is to heat a flat piece of iron or steel of mass sufficient to retain heat for a long time, and place the piece to be colored on the hot surface, sometimes in direct contact with the hot metal and at other times on a piece of sheet iron placed on the hot piece. When the desired color appears, brush off into an oil bath. Yet another way is the hot-sand method. A pan of sand is heated to a high degree, the parts are buried in it and rolled around, and when color appears check as before. In all these methods the colors that appear to the naked eye come in the following order: Pale straw, dark straw, brown, purple, blue and green, after which it loses itself—in white.

The wearing life of work done by these methods is naturally very short, as the colors rub off very quickly by handling.

Varnishing and Lacquering.

Varnishing and lacquering, as being apart from the subject matter, will be treated very briefly. The method cannot be used to produce an artistic color effect, but is nearly always used for the commercial reason—that of protecting the surfaces of instruments and machines from discolora-

tion by atmospheric influence in which is combined the action of air, moisture and the various gases.

In nearly every instance lacquering is used only on the alloys. It might be well in this connection to note the coloring power of metals in the alloys, as given by Lebedur, a noted German authority. He states that discoloring action upon metals takes place to the greatest extent upon tin and the least upon gold. In the following list of metals the action becomes less from the first to the last: 1, Tin; 2, nickel; 3, aluminum; 4, manganese; 5, iron; 6, copper; 7, zinc; 8, lead; 9, platinum; 10, silver; 11, gold.

Corroding Agents.

We now come to the corroding agents, chemical compounds, by which the really successful results are obtained, by the dipping process, or wet coloring, as it is called. While there are many methods known as dry coloring which have been repeatedly tried, where compounds are mixed together, forming pastes that are applied with a brush and allowed to remain any number of hours and then rubbed off, all are more or less failures. The wet method presents many advantages, both as regards economy of time and uniform results.

To color copper articles, such as ash trays, pin dishes, receivers, etc., a solution of ammonium sulphide will give the best results to the beginner. The greatest variety of colors, from light brown to black, can be obtained by this simple method. Use a dilute solution, cold. A good working solution is produced by diluting a saturated solution of ammonium sulphide with 10 to 40 parts of water.

The light brown color is produced by dipping for a very short time in the solution and withdrawing and allowing to dry in the air. The darker shade of brown is obtained by a longer immersion, according to the color desired, after which dry in sawdust. To obtain a black coloring allow the article to remain quite a little while in the bath and, after removing, dip the article in alcohol, after which the alcohol is burnt off, leaving a black coating. These colors can be permanently fixed by a transparent lacquer. The objection to ammonium sulphide is the great care necessary in handling, as it leaves an indelible stain upon the fingers, and it also has a very obnoxious odor. The ammonium sulphide also decomposes in time, depositing sulphur. It should be kept in a dark-colored and glass-stoppered bottle. It is not good for brass, being adapted only for copper.

Another solution for coloring copper which yields very good results is:

Copper nitrate	1 part
Water	3 parts

This forms a deposit of copper salt and, if heated, the salt is decomposed into a black copper oxide. The greenish tints are obtained by the following solution:

Ammonium carbonate	2 ounces
Ammonium chloride	2-3 ounce
Water	16 ounces

This solution gives good results on both copper and brass, different colorings being obtained by repeated dippings in the solution, allowing ample time between each for the articles to properly dry. As with copper, so it is with brass, many varieties of color can be obtained by different chemical solutions, but the desirable colors for commercial use are dead black and steely gray.

The following mixture has also given very good results for brass:

Hydrochloric, or more commonly termed muriatic acid,
White arsenic,
Silver.

Take any given quantity of arsenic, say ½ ounce, dissolve in strong muriatic acid, snip off a small piece of a silver dime if no other silver is at hand, a piece about ¼ inch in size. Heat the article to a dull red and dip in the solution; allow to remain until cool. This produces the dull black result so often seen on mathematical instruments. The steely gray is obtained in the same manner, except the article is not heated to such a high temperature as in the preceding case. By arsenic solution many good results are obtained by cold dipping also.

In every case where chemical solutions are used it is well to remember that the slower the rate of deposition the better the results, from the wearing standpoint; hence, the longer a dilute solution takes to deposit its coating, the better the color will last, and that is, of course, a very desirable quality.

Coloring Iron and Steel.

The coloring of copper and brass, especially copper, is for its artistic value alone; but from the purely commercial standpoint the coloring of iron and steel is of greater value, because it is used for so many machine parts and parts of guns, small arms, etc., which are treated to produce a blue or black color for the purpose of preserving the metal against corrosion, as well as to give it a handsome appearance.

The following solution will give very satisfactory results with iron or steel if carefully treated:

Take equal parts of potassium nitrate and sodium nitrate and fuse by heating the mixture until it is completely melted. The melting point of the mixed nitrate salts is 339 degrees Centigrade, or over 600 degrees Fahrenheit. Dip the articles first in boiling lye or strong hot soda water to thoroughly cleanse from grease; dip in the hot mixed nitrate flux and from there into boiling water to rinse off the nitrate. Different temperatures of the solution will produce different shades of coloring, and sometimes it will be found advisable to use the flux at a temperature as high as 700 degrees Fahrenheit.

In many cases where tempered articles are to be treated it would not be possible to bring the steel to the desired color by this process, because the temperature of the fused nitrates would be so high as to draw the temper of the articles. In such cases the old nitric acid rusting process is generally resorted to. The nitric acid is placed in an earthenware jar and inclosed in a box that can be made practically tight by closing the lid. The article is suspended in the box and the lid closed, and the fumes arising from the acid oxidize the surface of the article, and if the article is moistened before placing in the box a very much more rapid oxidation is assured, saving considerable time.

Many experiments have been tried with different mixtures for coloring iron and steel, where there is danger of drawing the temper of the metal, of which the following has proved very successful: A wooden box is used, of a size according to the kind of work you wish to do. A small steam pipe connects with the box, so that a quantity of steam may flow into it continuously and moisten the air in the box. A bath made of the following ingredients is then placed in the box:

Iron chloride (muriate tincture of steel)	1 ounce
Alcohol (spirits of wine)	1 ounce
Corrosive sublimate (mercury bichloride)	¼ ounce
Aquafortis (strong nitric acid)	¼ ounce
Blue stone (copper sulphate)	⅛ ounce
Water	1 quart

The vapor arising from this bath forms a deposit on the articles which are allowed to remain in the receptacle a number of hours, rubbed off with a cloth, and the operation repeated if a darker color is desired. Very rich coloring can be obtained by this process, after a little experiment; and the temper is not affected.

Many other solutions more or less successful could be included in this article, but enough has been given to enable anyone to get a variety of coloring in different metals and alloys.

Cleaning Old Brass and Copper.

In conclusion, it will be well to touch upon the method of cleaning old brass or copper from impurities. This is accomplished by what is commonly called a dip. The brass articles are strung on a wire, which should be of the same material as the articles, and dipped in the following solution:

1 part aquafortis (nitric acid).
6 parts muriatic acid (hydrochloric acid).
2 parts water.

The articles are first dipped in a strong hot solution of soda in water, and then into the bath, where they are swirled around for a time, removed and rinsed in cold water and dried in sawdust. If the metal looks dark and is not quite bright, the aquafortis should be weakened.

Where many pounds of small brass fittings are to be treated, they are put in an earthenware pot containing numerous perforations.

Zinc is often cleaned by dipping into a solution of

16 parts water,

1 part oil of vitriol (sulphuric acid)

for a few moments, and then washing thoroughly to remove all trace of the bath.

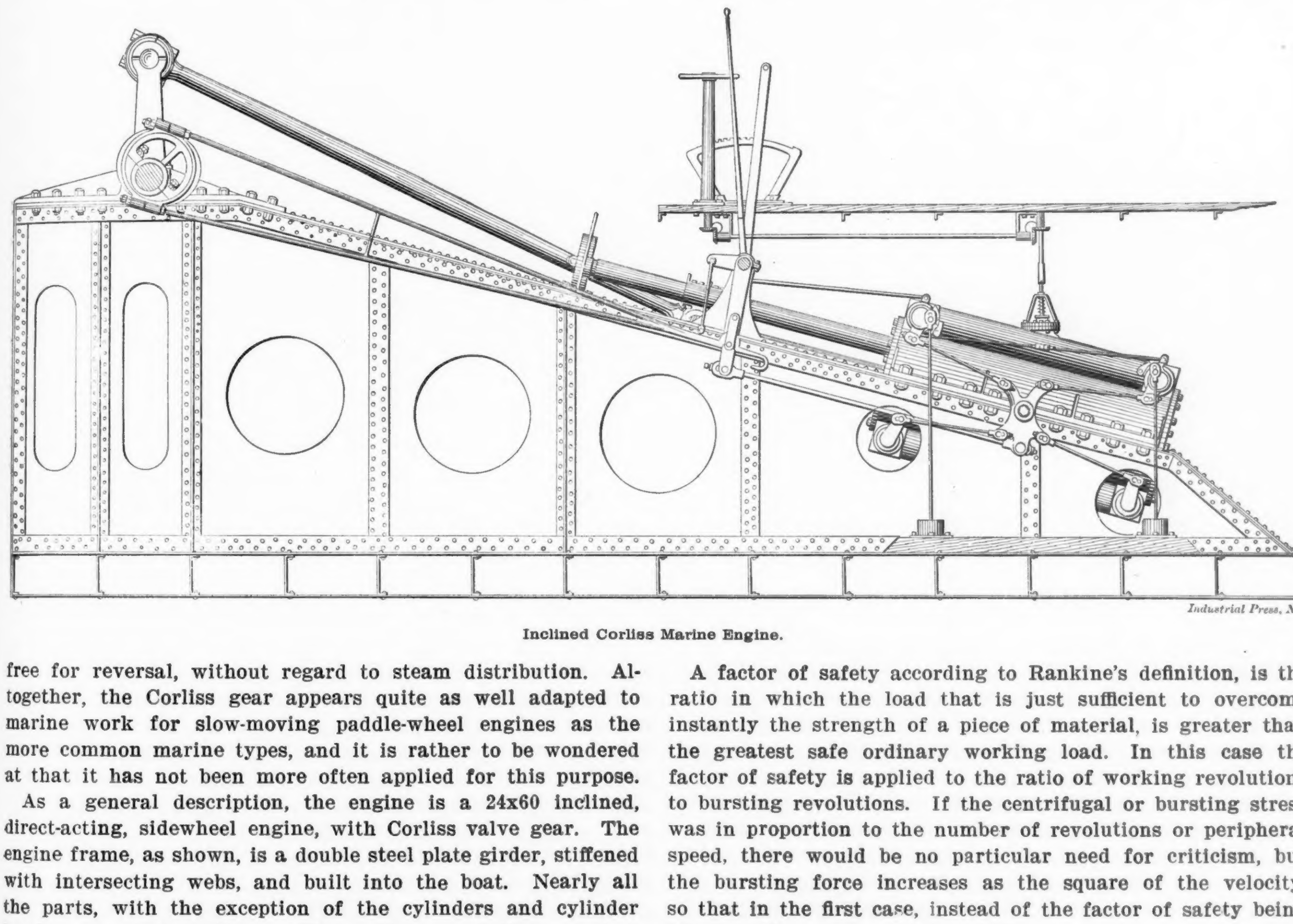
* * *

A MARINE ENGINE WITH CORLISS GEAR.

We show in the accompanying illustration an interesting type of river-boat engine that was installed on the steamer *H. B. Plant*, hailing from Port Tampa, Fla., by the Merrill-Stevens Engineering Co., Jacksonville, Fla. It was designed with special reference to extreme lightness, the steamer, complete, drawing only 32 inches of water.

The distinctive feature of the engine is that it is equipped with Corliss valve gear in place of the Stevens gear used so extensively here in the East, and the typical river-boat gear that is found on all the navigable rivers of the West. The Corliss gear gives an opportunity to change the point of cut-off in the engine cylinders, through changing the points at which the knock-off cams operate, without altering in any way the other features of the steam distribution, as shown by the indicator card. This leaves the link motion entirely free for reversal, without regard to steam distribution. Altogether, the Corliss gear appears quite as well adapted to marine work for slow-moving paddle-wheel engines as the more common marine types, and it is rather to be wondered at that it has not been more often applied for this purpose.

As a general description, the engine is a 24x60 inclined, direct-acting, sidewheel engine, with Corliss valve gear. The engine frame, as shown, is a double steel plate girder, stiffened with intersecting webs, and built into the boat. Nearly all the parts, with the exception of the cylinders and cylinder heads, are steel castings. The guides are hollow steel, 5 inches in diameter and ½ inch thick. The cross-heads have steel casting wearing surfaces, lined with white metal and hang below the guides, which are supported at the cylinder ends by bosses on the head and by steel guide bridges spanning the frames at the other end; the connecting rod is hollow, of forged steel. Main bearings and outboard bearings and wheel-centers all are steel castings, in order to get the lightest possible construction consistent with strength. The piston is a steel casting. The engine is operated with a surface condenser having 600 feet of cooling surface, supplied with circulating water by a direct-connected 6-inch circulating pump, with independent "Burnham" air pump. The performance of the engine has been very satisfactory, indeed; it has been driven at 40 revolutions with 100 pounds of steam, cut-off at 26 inches giving an indicated horse power of 440 and driving the boat at about 12¾ knots. The boiler supplying this engine is a Scotch boiler 8 feet 4 inches in diameter by 12 feet long, having 1,057 feet of heating surface; it furnishes steam for the maximum performance of the engine given above with natural draft, using wood for fuel.



Inclined Corliss Marine Engine.

* * *

"FACTOR OF SAFETY."

In the following, taken from a paper on grinding wheels, recently read before a trade association, what seems to us to be misuse of the term "factor of safety," appears:

"Professor Grübler, of Dresden, made a series of tests on abrasive wheels in May, 1902, for the Association of German Engineers. All manufacturers were invited to submit a 20-inch wheel, to be speeded till it burst. About 60 wheels, including nearly all the well-known kinds, were tested, and the results showed that all the specimens were safe if properly used. The proper working speed for a 20-inch wheel is 955 revolutions per minute, and the worst record for any wheel tested was 2,615 revolutions per minute, giving a factor of safety of about 2.7. The carborundum wheel tested gave the highest record, for it did not break till a speed of 4,340 revolutions per minute was reached, giving a factor of safety of about 4.5. This was one of the regular carborundum wheels made with a vitrified porcelain bond."

A factor of safety according to Rankine's definition, is the ratio in which the load that is just sufficient to overcome instantly the strength of a piece of material, is greater than the greatest safe ordinary working load. In this case the factor of safety is applied to the ratio of working revolutions to bursting revolutions. If the centrifugal or bursting stress was in proportion to the number of revolutions or peripheral speed, there would be no particular need for criticism, but the bursting force increases as the square of the velocity, so that in the first case, instead of the factor of safety being 2.7, it is the square of 2.7 or 7.29.

* * *

After certain tests of abrasive wheels made at Sibley College, the metal removed was micro-photographed. The photographs, it is said, show that the metal removed by emery wheels is in the form of minute globules; that from carborundum wheels is in the shape of chips or shavings. This seems to show that an emery wheel "grinds" or wears the metal off while the carborundum wheel cuts it off in a manner much the same as a milling cutter. This is an important distinction. It not only indicates that the carborundum wheel should be the most efficient in metal removed for the same power, but that heating should be much less since it is cut off instead of being abraded by friction. The wheel that heats the least, other things being equal, should give the most accurate work.

Entered at the Post-Office in New York City as Second-class Matter.

MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

CHICAGO OFFICE—1462 Monadnock Block.

LESTER G. FRENCH, Editor.
FRED E. ROGERS and GEO. H. HALL, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

DECEMBER, 1903.

NET CIRCULATION FOR NOVEMBER, 1903,—25,324 COPIES.

MACHINERY is issued in three editions—the Engineering Edition, printed on coated paper throughout, each volume comprising 650 or more reading pages and forty-eight 6 x 9 data sheets—price $2.00 a year; the Shop Edition, printed on super-calendered paper, comprising 430 or more reading pages, devoted to practical shop matter—price $1.00; and the Foreign Edition, which comprises the same matter as the Engineering but is printed on thin paper for transmission abroad—price $3.00 a year.

IMPROVING THE STEAM ENGINE.

Not infrequently an editor of a technical paper is called upon to give advice or express an opinion regarding some invention; or it may be that an invention is submitted to him for publication. Very many of such inventions are thoroughly good and must meet with favorable consideration, but there are so many more that are obviously of little value, or perhaps totally useless that it frequently becomes the painful duty of the editor to try to discourage the inventor in his work, and perhaps lose him as a friend for some time to come, or else say nothing at all and let the inventor hang himself with his own rope.

Some time ago we received a letter from a subscriber, inclosing a clipping from the local paper about a steam engine that the writer of the letter had invented. The machine was in operation in the printing office and from the fact that it made the wheels go round and seemed to run very nicely, the editor of that paper wrote a dissertation upon the wonders of the invention and predicted a rapid journey along the road to wealth for his friend, the inventor. The particular merit of the engine was that it accomplished a "long-sought-for method" for doing away with the tremendous losses incident to the crank and connecting rod of a steam engine. The inventor had discovered that designers of all other engines made the great mistake of letting steam into the cylinder at full pressure at the beginning of the stroke, and then cutting off the steam early in the stroke, allowing the pressure to drop to almost nothing at the end. Obviously this is wrong, so he thought, because the steam drops to a low pressure at or near the middle of the stroke, where the crank and connecting rod are in positions to exert the greatest power. Worse than that, the pressure is greatest at the beginning, where the leverage is small, and so, of course, there must be a great deal of power wasted. Why not arrange the valves to give the greatest pressure near the middle of the stroke where the leverage of the crank is greatest, and have the pressure small at each end? And this is what the inventor did!

In another clipping sent us is an elaborate description of a wonderful engine that is certainly an epoch marker. It says, "All mechanics know that the steam engine, as now used, loses one-half its strokes by its reciprocal movement," though we do not quite see what becomes of the lost strokes. The inventor has therefore produced a rotary engine which has no strokes to lose, and which he proclaims "has no motion and makes little noise." The remarkable thing is that it can make even a little noise without any motion.

But the most attractive proposition that has come to hand relates to a new engine which the inventor frankly admits "seems to embody a mechanical anomaly," for, while the mechanism gains power over the crank form of engine it requires less energy in the form of coal to develop power. It promises "to make navigation of the air perfectly practicable, to place the automobile within the reach of everybody who can afford a bicycle, to give railroad transportation the 125-mile-per-hour locomotive, and to give ocean navigation a power that will overcome the momentum of an ocean greyhound in one minute, instead of five minutes now required." He accomplishes this by the simple expedient of a coarse-pitch spiral operated by a nut, which is given a reciprocating motion by the piston rod, and thus saves the 101 per cent. usually lost by the cumbersome crank and connecting rod.

We know that many valuable inventions are made by men who approach a subject from the outside and are untrammeled by custom, or rule-of-thumb. The very fact that they are not familiar with what has been done and the way in which it has been done, enables them to bring a fresh mind to the problem, and to think independently and sometimes more effectively than one whose mental attitude has been influenced by a knowledge of the way others have accomplished a result. But where there is one commercially successful invention by a man not acquainted with the state of the art, there are hundreds that are not successful, and the safe rule to follow—a rule which we should like to impress upon such of our readers as cannot afford to enrich patent lawyers, without some return for themselves—is to first become familiar with what has been done, the way it has been done, and why it has been done. Then, in the light of this knowledge, go ahead with your invention if you think best. We could cite many instances of failures in invention, simply because the inventor acquired his knowledge after the patent was issued instead of before, but the three cases referred to above are sufficient to show what futile schemes a person will spend money on, when a little time devoted to study would have taught him better.

* * *

A press item states that the law in Ohio requiring stationary engineers to pass an examination has been declared unconstitutional. The decision was rendered in the case of an engineer who some months ago was fined for disobeying the law. Dispatches give very meager information, merely stating that the judge declared the statute to be a hardship against those engineers who, by years of practical experience, have thoroughly mastered the practical workings of an engine, but may not be able to answer technical questions.

We have no information about the circumstance of the case. In general, we do not believe in many of the questions commonly asked engineers at examinations. Safety valve calculations, for example, do not amount to anything at all, so far as determining the ability of an engineer to properly operate a steam plant, and many perplexing and useless questions are often propounded that may only serve to confuse a good man. Nevertheless we do not understand on what ground a judge should pronounce examinations unconstitutional. There is scarcely a law on the statutes which might not in some one of its phases abridge the rights of some person and so be "unconstitutional." It should be understood, however, that when a man takes charge of a steam plant he becomes nothing less than a public servant. The safety of the public depends as much upon the proper conduct of his plant and the public has as much right to demand that it shall be safely conducted, as in the case of a hotel, a railroad, a steamship or a mine. These and other public institutions are amenable to public safety and convenience and it is right that every means, legal if necessary, should be taken to protect the public. In the case of the railroad—usually a great system in which it is possible to take men from the ranks and train them for the important positions—examinations for engineers are not so necessary, though the general management of the road must be in conformity to the law. But in the case of individual power plants, owned and operated by Tom, Dick and Harry, who is to insure the safety of the public if the State does not?

HITCHING THE MOTOR.

In machine tools a noticeable feature is the changes in general appearance which the increasing use of the direct motor drive is developing. With lathes especially the first applications of the electric motor concerned the substitution of the motor for belt drive at the countershaft. Next the motor was mounted on a bracket of the machine and connected to the spindle or spindle gearing by means of a chain belt. As yet the lathe itself has not changed. In the later machines, however, the spindle pulley is removed and the motor itself mounted directly in the head—the necessary gearing being disposed around the exterior ends of the motor. These changes, together with those incidental to the modern quick-feed changing mechanisms, make the newest machines present a quite different appearance from the standard forms in general use until quite recently.—*Exchange.*

Contrary to the inference of the above, and unfortunately for the progress of electric machine-tool driving, it is, in the present state of the art, bad design to make an electric motor an integral part of a machine tool. This condition exists because of the still primitive state of the electric motor, which makes it quite necessary to be able to quickly replace a burnt-out armature, etc. If the armature is mounted on a shaft which forms a part of the machine, such as a lathe spindle, for instance, it is special, and its replacement is a matter of days or weeks, depending on the distance from the factory, their promptness, etc. But if a standard motor is used, the replacement of a burnt-out armature, or of the entire motor, is a simple matter. If one make of motor is not available, another generally can be readily substituted. It is true that one of the first attempts at driving lathes with electric motors was made by building the motor in the headstock and mounting the armature on a quill which corresponds to the cone pulley, but this design was a failure. A stroll through the machine shop of an electric concern, well known for their efforts along these lines, will discover a number of engine lathes, originally built with the motors in the headstock, but now equipped with standard motors mounted on the field rings of the old motors. They found that their lathes were lying idle too much of the time, because of repairs to the motors, and so abandoned the idea. When some better means of insulating the windings of motors are discovered than now known, it may be feasible to make them part of the machine tools, but it emphatically is not so now, except, perhaps, in the case of some small tools like grinders or drills.

* * *

LECTURE UPON "THERMIT."

On the evening of Nov. 13 an opportunity was given to hear a lecture by Dr. Hans Goldschmidt on the compound "thermit," at Columbia University. Since the illustrated articles upon thermit in the March, 1903, number of MACHINERY there have been numerous articles and items published upon this wonderful compound in various American papers, and a great deal of interest has been aroused in this preparation and its possibilities.

Dr. Goldschmidt has recently come from Germany for a short stay in America, for the purpose of further familiarizing engineers and chemists with his invention, and it is probable that an American company will be formed in the near future for the manufacture and sale of thermit in this country.

Thermit is a metallic powder, the main ingredients of which are aluminum and oxide of iron, and by inducing a chemical combination of these two elements through the use of a suitable igniting agent such as superoxide of barium, the whole becomes a molten mass at a temperature about equal to that of the electric arc. Ignition once started, the combustion is continued throughout the whole mass of the powder without any external supply of heat. Thermit is applied most profitably, and at the present time most extensively, in various welding operations, although it has certain metallurgical uses of great importance. By suitable preparation of the thermit mixture it is possible by the combustion process to produce pure chromium, pure manganese and other elements used in the manufacture of high-grade steel. It is also employed in the casting of steel ingots and to prevent piping which occurs at the ends of the ingots, due to unequal cooling of the metal in the mold. After the steel has become partially cooled and piping has set in, thermit is introduced near the center of one end of the ingot and by its combustion the steel is heated to a welding point. Steel which is held in readiness is then poured into the cavity and unites with the ingot.

The lecture was highly interesting, illustrated as it was by many experiments and a large number of lantern slides showing practical applications of thermit for welding. At present it is used more extensively for welding street car rails than for any other purpose, although a more striking illustration of its possibilities consists in certain marine repairs that are possible at trifling expense. For example, photographs were shown of stern and rudder posts that had been repaired in a comparatively short time, whereas by the usual method the forgings of which they were a part must have been removed and new ones substituted, while the vessel remained in drydock for several weeks at enormous expense of time and money.

In welding rails the rails are usually held together by suitable clamps, although this is not necessary. The joint is surrounded by a clay mold which fits the rail closely, and the thermit runs from the crucible in which it has been ignited into the mold. The rails reach a welding heat at the joint, and any space between is filled by the molten thermit which itself has a high tensile strength equal to about two-thirds of the strength of the rail; but as the mold is so shaped that the thermit forms a chair for the rail at the joint when it solidifies, it really makes the welded portion considerably stronger than the body of the rail. After the joint is completed the fin of thermit iron formed at the top of the rail at the joint is chipped off.

To say that a full-sized street railway rail was welded in about three minutes' time in the lecture room, as one of the practical illustrations of the application of thermit, will perhaps more forcibly impress upon the reader than any other statement what it is possible to accomplish by the application of intense heat at the point desired and in just the necessary quantity. In contrast to this we have the labor and time and amount of heat wasted from forge fire by the usual process of welding.

To show the intense heat of thermit a little of the molten metal was allowed to flow upon a wrought-iron boiler plate about ½ inch thick and almost instantly it melted a hole through it 1 inch in diameter.

The experiment that captivated the audience, however, was the illustration of what could be done in welding wrought-iron pipe. It will at once be apparent that the application of such thin metal as is used in wrought-iron pipe would at once melt the metal and leave nothing to be welded. This would be true if thermit were poured directly into the mold surrounding the pipe at the joint, from the bottom of a crucible. Instead the thermit is poured into the mold from the top of a crucible, with the result that the slag formed on top first runs into the mold and adheres to the surface of the pipe, forming a thin layer over the surface. This coating of slag protects the pipe and instead of its melting, it is simply brought to a welding heat. The pipe is held by clamps and when the right temperature is reached the clamps are tightened slightly and then almost at once removed. The thermit iron is easily knocked off from the pipe since it does not adhere to the slag, and a perfect joint is the result.

There is no doubt that thermit and the many uses to which it can be put is one of the most interesting topics that has been brought to the attention of engineers during the past few years. The fact that welding can be accomplished by so simple a process would have been discredited by everyone, especially by those not acquainted with the development in thermo-chemistry previous to Dr. Goldschmidt's work.

In the articles which appeared in MACHINERY last March there were illustrations, from photographs, of welding operations, and the subject was treated so thoroughly that it will not be necessary to go into it more in detail at this time.

THE STEAM EQUIPMENT OF A MODERN SCHOONER.*

Until within comparatively recent times it has been customary for all of the work upon sailing vessels, such as raising the sails, heaving the anchor, etc., to be performed by the sailors; and with an increase of tonnage was required a corresponding increase in the size of the crew, so that one of our present "6-masters," had they then been possible, would have required a small regiment for her operation. The use of auxiliary steam appliances naturally began upon steam vessels where the power was at hand and was, from the first, used for operating the pumps and later for the windlass, ash hoist, etc. Having proved so useful upon these vessels it was not long before it was adopted upon sailing vessels, and at present all schooners of any size are provided with a steam equipment comprising a boiler, used both for power and heating purposes; steam winches, for anchor, sail and cargo hoisting, and an outfit of pumps which forms a complete local waterworks system.

This outfit is located in the "fo'castle," where room is scarce and the arrangement must, therefore, be as compact as possible. Fig. 1 shows a typical outfit such as would be found on the ordinary coasting schooner. The boiler is of the vertical, tubular type, and should be capable of carrying a steam pressure of 100 pounds although, except when raising anchor or discharging cargo, it is usually run at low pressure for heating purposes. A steam whistle is provided so that safety as well as comfort are ensured.

The principal appliance to be installed in the engine room is the steam winch, which is used for handling the cargo, hoisting the boats and for warping the vessel into dock. The engines are of the duplex type with cranks set at 90 deg., so that it is impossible for them to get on "center." The main drum is friction-driven and provided with a powerful band brake, which is used when lowering cargo into the hold. The winch shaft extends to starboard and port beyond the winch proper and, passing through the sides of the deck house, is provided with small drums, or "ends," over which a rope may be run, forward or aft, for sail hoisting, boat handling, or for warping purposes. On the larger schooners

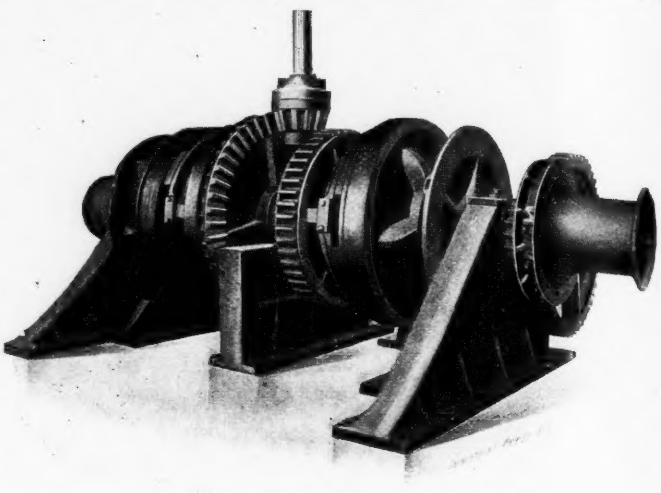


Fig. 2. "Providence" Elastic Windlass (arranged for Messenger Chain Attachment.)

two or three auxiliary winches are often supplied, being placed at convenient positions near the masts.

One of the most important items to be considered in this class of engineering is the economy of fresh water which must, of course, be carried in tanks and every provision is therefore made to prevent any loss. The supply for the boiler is carried in a tank placed in the engine room, while a reserve supply is held in large storage tanks located in the forward and after holds. Upon the top of the feed tank is placed a coil condenser, to which are connected the exhaust pipes from all of the engines and pumps in the system. Incidentally, the exhaust pipe is continued beyond the con-

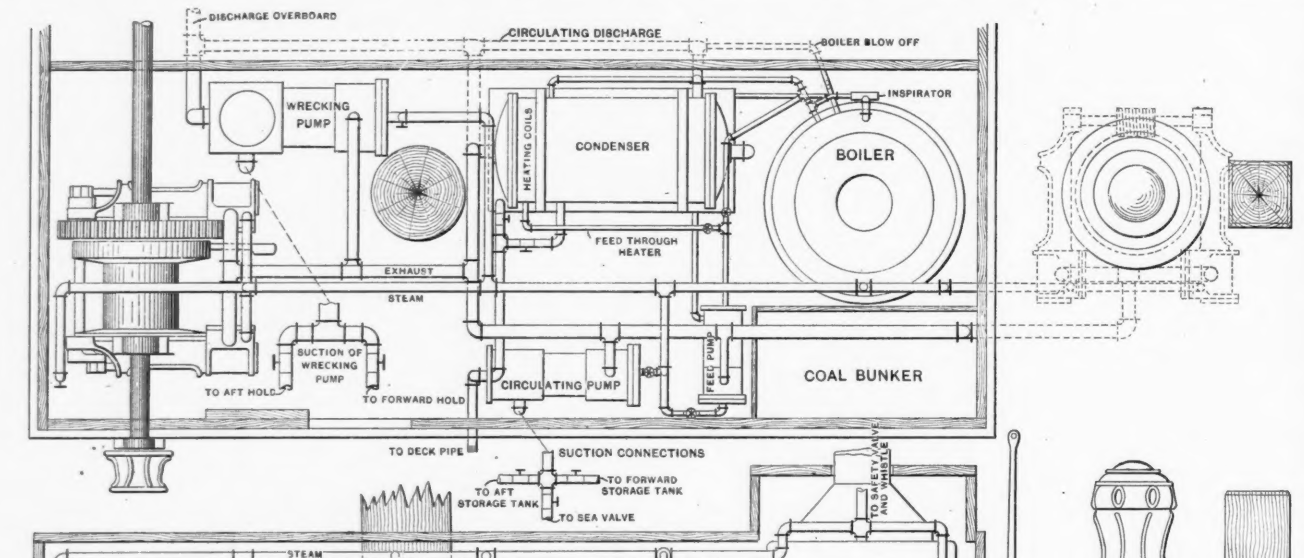


Fig. 1. Plan and Elevation of a Typical Steam Outfit for a Modern Schooner.

* For much of the information embodied in this article, together with the photographs, we are indebted to the American Ship Windlass Co., Providence, R. I.

denser, under the deck, and connects with the discharge from the circulating pump so that, in case of accident to the condenser, all of the exhaust steam may be discharged overboard. The first few coils of this condenser are separated from those used for condensing purposes, and are introduced into the boiler feed system so as to form a feed water heater. The remaining coils are connected to the circulating pump, which has a suction connection with the sea valve, and from the condenser the circulating water, as before noted, passes overboard. No air pump is used with the condenser and consequently no vacuum is obtained, as the object of the condenser is solely

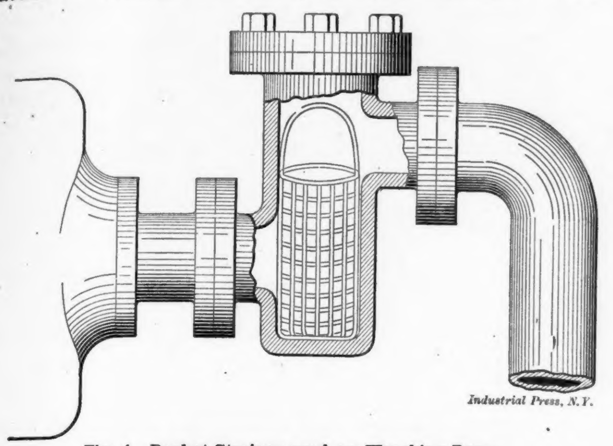


Fig. 4. Basket Strainer used on Wrecking Pump.

for water economy. We here find a great advantage in the unlimited supply of condensing water at hand and this is used without stint in order to effect a saving of the valuable fresh water.

The circulating pump has by-connections whereby the salt water may be cut out and fresh water drawn from either forward or aft storage tank and pumped into the feed tank. This pump is also used for deck washing or fire extinguishing purposes, at which times it is, of course, placed in the salt water circuit. Extending along under one of the ship's rails is a pipe which is provided, at intervals of 25 or 30 feet, with plugs to which a fire hose may be attached, and this pipe is connected with one of the discharges from the circulating pump by means of a flexible hose connection which is removed when the pump is not in use for this purpose. All of the pipes through which salt water is to pass should be of brass or galvanized iron, as the action of salt water upon ordinary wrought iron pipe is very detrimental.

The boiler is fed by a small duplex steam pump and is also provided with an inspirator so that either system of feeding may be employed as desired and the one arrangement acts as a substitute for the other in case of accident. In the engine room is also placed a larger duplex pump which is used solely for wrecking purposes, that is, for keeping the bilge clear of water and when the vessel is leaking. The suction is divided, one part running directly down to the forward hold and the other aft to the after hold. Much care must be exercised in keeping these suctions clear, as it is of greatest importance that they should work freely in case any leaking occurs. A peculiar type of strainer is employed, being what is known as a basket strainer. This is placed in the first elbow of the pipe so that it may be removed and cleaned whenever desired and a surprising quantity of dirt and rubbish, to say nothing of dead rats, is often found in these strainers from the bilge.

Besides the important steam appliances here mentioned, steam from the boiler is also used for heating purposes so that the old fo'-castle" stove is now replaced by a modern steam coil and the captain's cabin aft is provided with radiators, and a bath room supplied with hot and cold water. A telephone also is often installed, establishing communication between the cabin and the engine room.

Last but by no means least of the appliances for which the steam equipment is installed, is the windlass, which is situated well forward and carries the two chains by which the anchors are raised. In the construction of windlasses there have probably been more improvements during the past few years than in any other single appliance used upon sailing vessels. Formerly the windlass was operated by a capstan, in the head of which were inserted long capstan bars. These were manned by nearly the entire crew and with a hearty "heave ho" song they tramped round and round until slowly the cable was wound in and the heavy anchor "weighed." The picturesque part of weighing the anchor is now passed but the capstan is still retained for use in case of a breakdown in the steam equipment. It may also be entirely disconnected from the windlass, by simply removing a block key. We then have an efficient warping capstan operated directly by the windlass engines.

As soon as it became customary to place a boiler and winch on board of a schooner, arrangements were made for connecting the winch to the windlass so as to do away with the necessity of manual labor; and this arrangement consisted of placing a sprocket on the winch shaft and connecting it by means of an open link chain called a messenger chain, to an auxiliary shaft mounted back of and geared to the windlass shaft. Although very serviceable, and still employed to some extent, the arrangement was at best only a makeshift, and gave trouble, owing to the stretching of the chain and its liability to break at just those times that it was most depended upon. A remedy for all of these annoy-

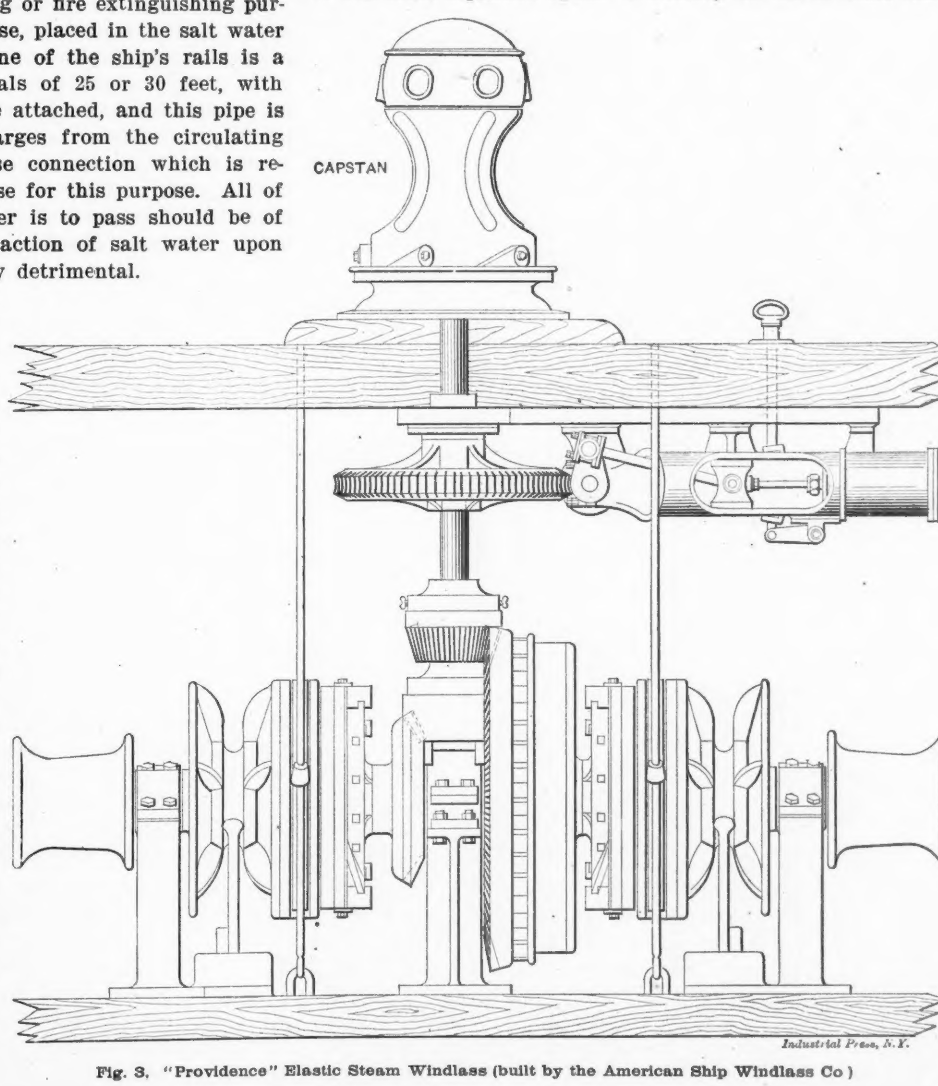


Fig. 3. "Providence" Elastic Steam Windlass (built by the American Ship Windlass Co)

ances was found by arranging for the direct connection of the windlass with an auxiliary pair of engines as illustrated in Fig. 3. Upon the windlass shaft is fixed a large bevel gear, which is driven by a bevel pinion on the vertical capstan shaft. Upon this shaft is keyed a worm gear, which is driven by a pair of horizontal engines, similar to those used on the winch, and fastened to the deck above the windlass. The chains pass over chain wheels, called "wild cats," which are loose on the windlass shaft and when paying out chain, or riding at anchor, their motion is regulated by means of friction bands. To raise the chain, block keys are inserted between the wild cat and a driving head which is keyed to the

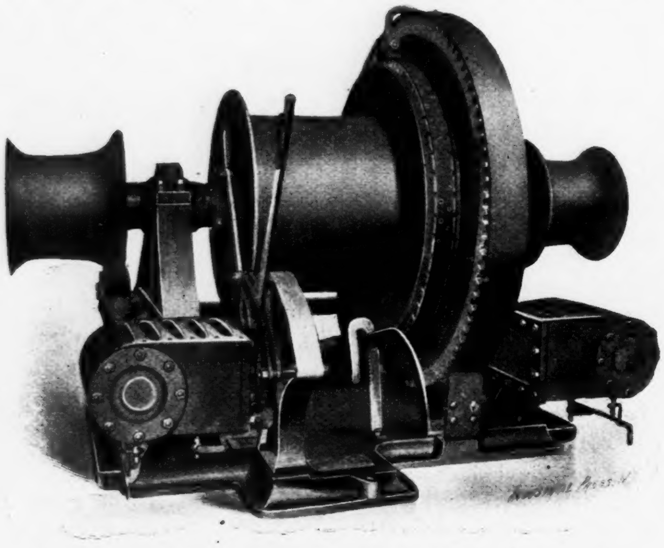


Fig. 5. Seven in. x 10 in. Steam Ship's Winch (built by American Ship Windlass Co.)

shaft and when the windlass shaft is driven by the engine the wild cats wind up the chain. One of the latest improvements to be applied to the windlass is the use of "elastic wild cats," for the purpose of relieving the strain on the ship, due to its rising on the surges when riding at anchor, and also when breaking out the anchor preparatory to raising. Fig. 6 shows a view of one of the wild cats and illustrates how this is accomplished. Between the driving head and wild cat is placed a secondary head, *A*, which carries four very powerful coiled springs that act as a connecting medium between the wild cat and itself. When the ship is riding at anchor these secondary heads are locked by means of the friction bands, so that no chain can be paid out. As the surge

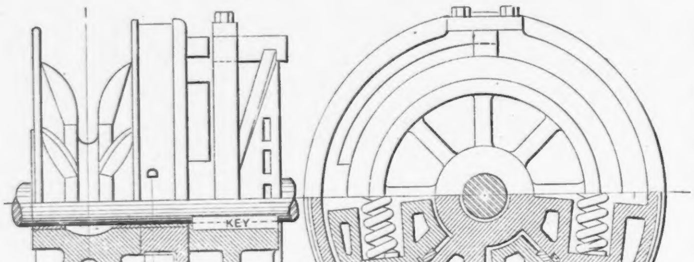


Fig. 6. Section of Spring Head of "Providence" Elastic Windlass.

raises the vessel, the strain that would otherwise be brought as a sudden shock upon chain and windlass shaft is instead absorbed in a gradual compression of the springs. This greatly relieves the chain and lessens the liability of its parting. In breaking out the anchor the secondary heads are temporarily keyed to the regular heads, *B*, and the elastic principle again comes into play.

It would be practically impossible to provide engines of sufficient power in themselves to pull out the anchor when it is securely imbedded in the bottom, but the engines draw in the chain until the vessel lies directly over the anchor with the chain pulled up taut. As the ship sinks in the trough of the sea the cable is tightened still more so that as she rises on the succeeding surge her entire buoyant force is exerted upon the chain and the anchor broken out. The elastic movement of the wild cats, although only about three-quarters of an inch, is yet sufficient to prevent this strain from coming as a heavy shock upon the windlass and changes it to a gradually applied load which the windlass is fully capable of withstanding.

Thus the use of steam upon sailing vessels not only adds to the comfort and safety of the crew but has to a great extent reduced the number of men needed to handle a ship of given tonnage, and made practical the building of greater tonnages than was considered possible when all of the labor had to be performed by hand. The reduced force needed for handling these larger vessels has made the schooner, with full steam equipment, without doubt the cheapest carrying medium for all freight in which quick delivery does not have to be considered.

G. H. H.

* * *

MACHINE TOOL BUILDERS' ASSOCIATION.

The convention of the National Machine Tool Builders' Association was held at the Hoffman House, New York, Nov. 10-11 and resulted in the agreement of the members to maintain existing prices for machine tools, in spite of the possibilities of a depression, resolutions to this effect having been adopted which will be issued in circular form and distributed among the trade.

This convention is looked upon as one of great importance to the machinery market, from the fact that the action in the matter of prices will tend to produce a more stable condition both among buyers and dealers of machinery who have, previous to the convention, not known what to depend upon in this regard.

Several addresses were delivered during the sessions. William Lodge, of the Lodge & Shipley Machine Tool Co., Cincinnati, in dwelling upon the future machine tool trade in the United States advocated the standardizing of parts of machine tools of different manufacture by adopting the same sizes of main bearings, nose of lathe spindles, etc., as well as widths and diameters of countershaft pulleys and countershafts themselves. Under the new order of things, with high-speed steels, he advocated two distinct classes of machines—one for cast-iron work and the other for steel work. He also advocated the maintenance of prices and urged upon the members to work honestly and faithfully to this end.

W. P. Davis, of Rochester, N. Y., related his experiences during a trip in Europe and stated that machine tools were being built at much less cost on the continent than in America excepting where we specialize and manufacture in large numbers, as is generally the case. In Europe concerns tend to produce a great variety of products, which renders them less able to compete. He fears most from Germany, where many large manufacturing plants are going up.

Joseph J. Flather, President of Flather & Co., Inc., Nashua, N. H., read a paper on "What Shall We Do on a Declining Market?" in which he contrasted present conditions with those existing in 1873. There is a great similarity between these periods, both in labor conditions and in the state of the market, but we have the advantage now in that we have stable money. He advocated the maintenance of prices and believed that the machine tool business would hold its own during any depression that may come.

P. E. Montanus, of the Springfield Machine Tool Co., delivered an address in which he held that many branches of the machine trade enjoyed greater advantages and were in a position to make greater profits than were machine tool builders who were producing higher grade products, but were receiving prices small in comparison with many firms building cruder machines by the aid of these tools.

William Lodge was elected president for the coming year; W. P. Davis, vice-president; F. E. Reed, second vice-president; Enoch Earle, treasurer, and P. E. Montanus, secretary.

BLOWING ENGINES WITH MECHANICALLY-OPERATED PISTON VALVES FOR AIR CYLINDERS.

The Westinghouse Machine Company have recently built six blowing engines of the long-crosshead type, three of which have been installed in the plant of the Toledo Furnace Company of Toledo, Ohio, and three at the plant of the South Chicago Furnace Company, at South Chicago, Ill., all under the general direction of Mr. Julian Kennedy, of Pittsburg, Consulting Engineer for the two companies.

These two plants are practically duplicates, each consisting of three engines arranged in line, with the intermediate unit designed to run as a low-pressure engine in conjunction with either of the other two which operate on high-pressure steam, compounding being effected through a receiver in the exhaust system of the high-pressure engines. The low-pressure unit is also arranged to run on high-pressure steam through a reducing valve. These three engines, each of a capacity equal to 2,000 horse power are designed to run in couples, either condensing or non-condensing, one being held in reserve. The steam cylinders of the high-pressure engines are 50 inches in diameter and of the low-pressure 96 inches diameter, and all have a stroke of 66 inches. The air cylinders of all the engines are 96 inches in diameter.

It is interesting to note that the materials entering into the structure of the engines were all supplied under the specifications of the International Association for testing materials. All large and important cast-iron parts were made of gun-iron melted in the open hearth or air furnace and possess a tensile strength of about 30,000 pounds per square inch. All steel castings were thoroughly re-annealed and all important forgings were made of steel, supplied by either the Bethlehem or Midvale Steel companies.

The bedplate is cast in one piece. The bottom portion of the main shaft bearings is a removable shell; these bearings are lined with babbitt metal, pened, both bored to size at one time with a special boring apparatus to insure alignment. Caps for the bearings are in one piece having overhanging lips with scraped fit to prevent side play, and are babbitted. The flywheels are 22 feet in diameter, of air furnace iron, and weigh 63,000 pounds each. The hub of each wheel is a crank disk, faced and turned with a recess on its periphery. The rims and arms of the wheels are cast in halves and counterbored to form a collar which fits into the recess in the periphery of the crank disk. The arms are fastened to the hub by bolts, keyed to prevent turning, and the joints of the rim are secured by internal links.

The main shaft is of hydraulically forged open hearth steel of from .40 per cent. to .50 per cent. carbon. The crank pins are high grade steel forgings containing about .50 per cent. carbon. They were ground true on centers and forced into the crank disks by hydraulic pressure and afterward riveted. The parts which serve as bearings for the connecting rod boxes are 12 inches in diameter by 11 inches long.

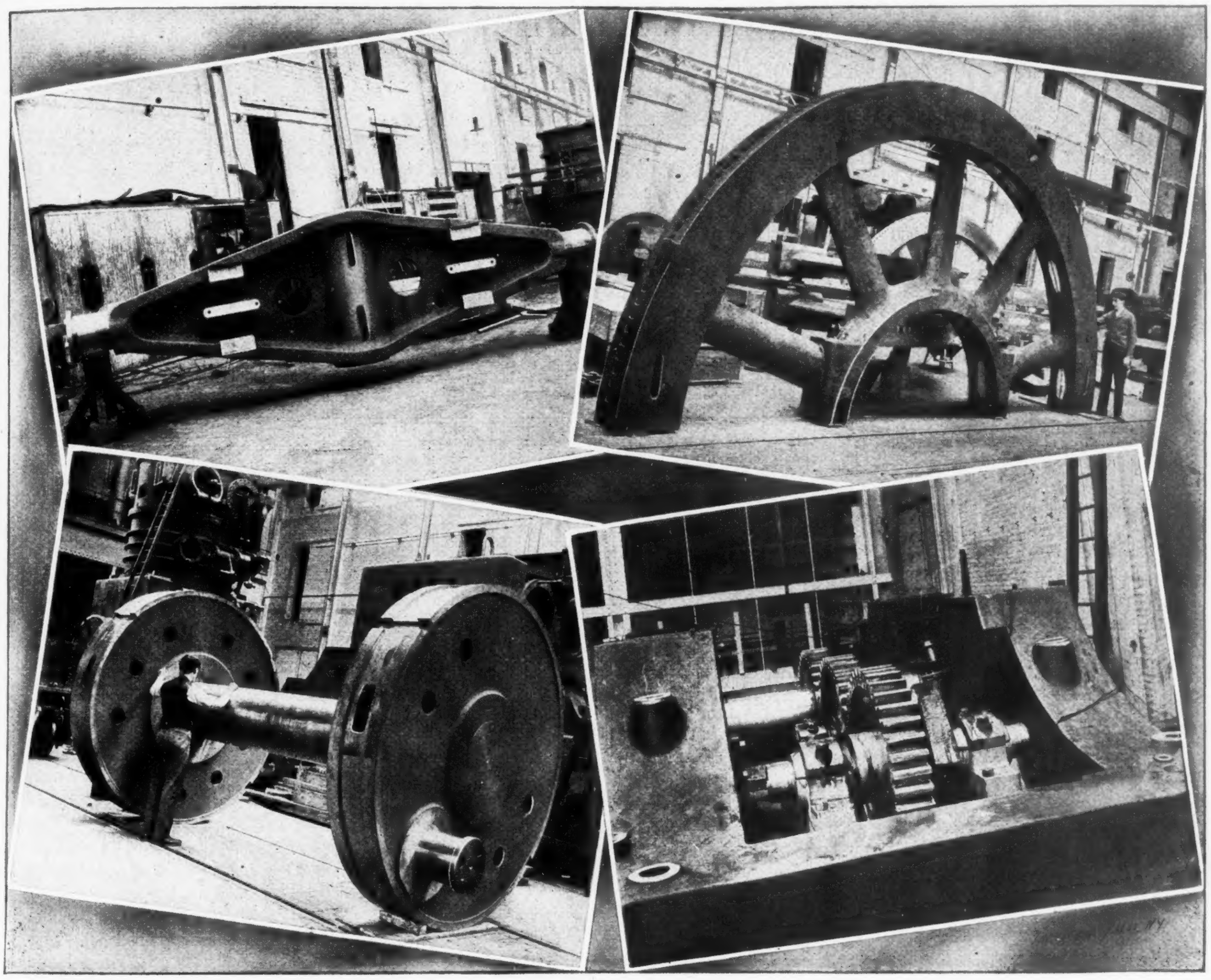


Fig. 1. Engine Details. The Crosshead is a Steel Casting 4 feet deep and 15 feet long. The Crank Disks serve also as Hubs for the Flywheels, which are bored out to fit. The Gearing in Bedplate is for Driving an Auxiliary Crank Shaft for Operating the Valve Gear.

Each engine has two connecting rods of open hearth forged steel of from .25 per cent to .30 per cent. carbon, finished all over. They are of the solid end type, each end provided with air furnace cast-iron boxes, babbitt lined and having adjusting wedges so arranged as to take up wear, while maintaining as nearly as possible a constant length. The piston rods are open hearth steel forgings containing .50 per cent. carbon. They are carefully machined and ground true and smooth.

The crossheads are of annealed steel castings of about .30 per cent. carbon. The ends are turned to form crosshead pins, each 12 inches in diameter, 11 inches long. The crosshead

shoes are of cast iron, faced with babbitt metal and bolted to the crossheads, adjustment for wear being provided by inserting liners. Especial care was taken in designing the crosshead to have an ample amount of metal, so as to provide a large margin of safety, where the stresses are most severe. The castings were inspected to insure their being thoroughly sound and solid, and the initial foundry strains were eliminated by the annealing process. The pin surfaces were finished true by grinding, and the boring for both piston rod fits was made with a bar at one setting. An idea of the massiveness of these castings may be had from the fact that the depth along the vertical center line is 4 feet, 2 inches.

The crosshead ends of the piston rods are turned cylindrical and are inserted into sockets in the crosshead with a slip fit, so that each strikes the bottom of its socket. A taper steel key is driven through a keyway, cut through the crosshead and rod, to hold the two together, and this keyway is offset in the two pieces so that when the key is driven in it forces the rod with great pressure upon the crosshead at the bottom of the socket. By this means a positive connection is insured, there always being an excess of pressure in one direction, notwithstanding the alternations of stress in the rod, due to the reciprocating action of the engine.

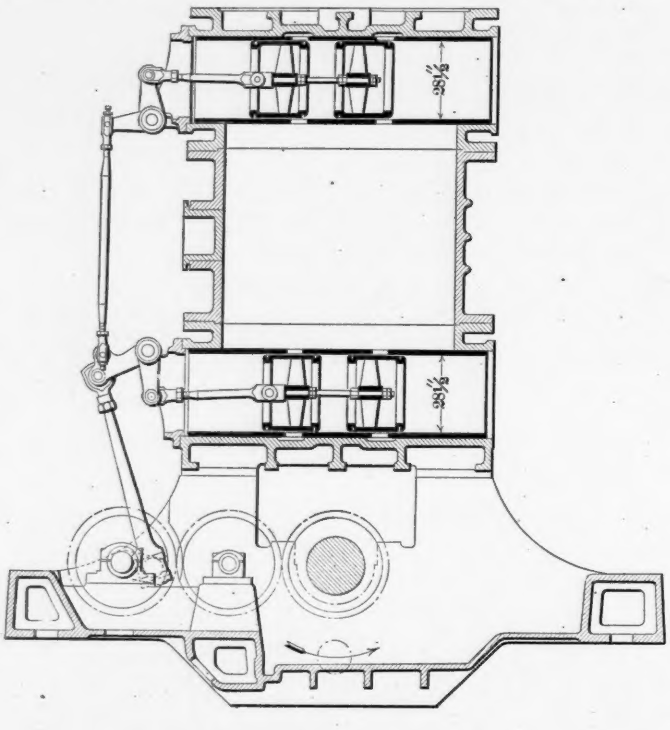


Fig. 2. Section through Air Inlet Valves

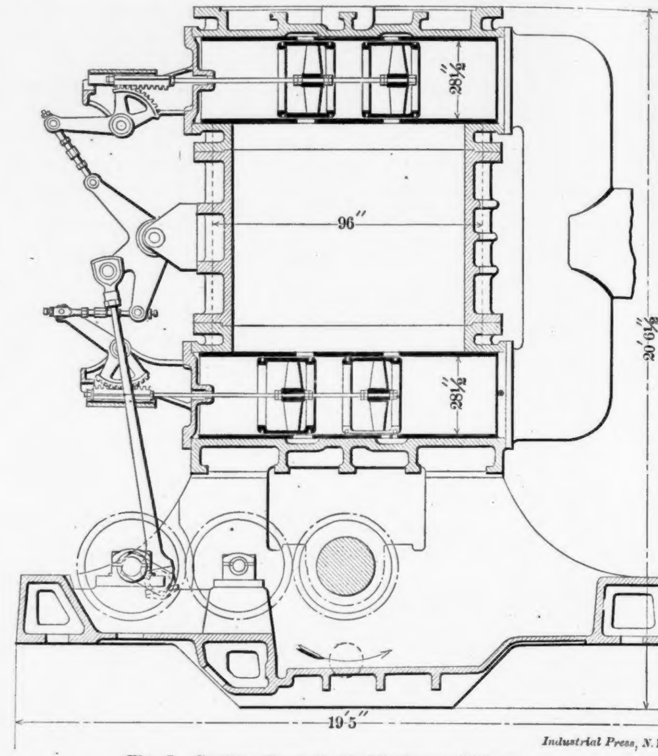


Fig 3. Section through Air Discharge Valves.

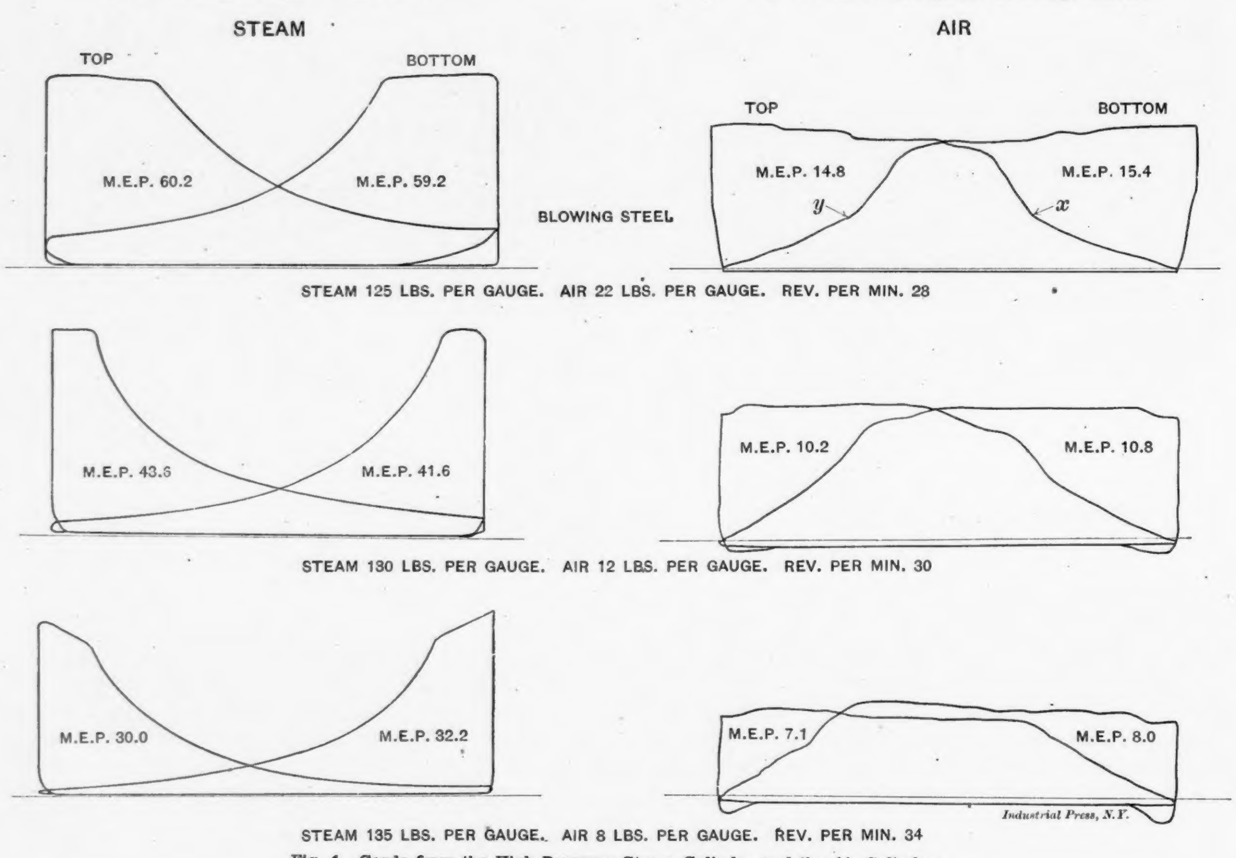


Fig. 4. Cards from the High Pressure Steam Cylinder and the Air Cylinder.

The steam cylinders are of hard close-grained air furnace iron. The walls were cast sufficiently thick to allow of reboring ½ inch diameter larger than called for on drawing. The exhaust box is cast separate from the cylinder and does not come in contact with the walls, thus reducing internal

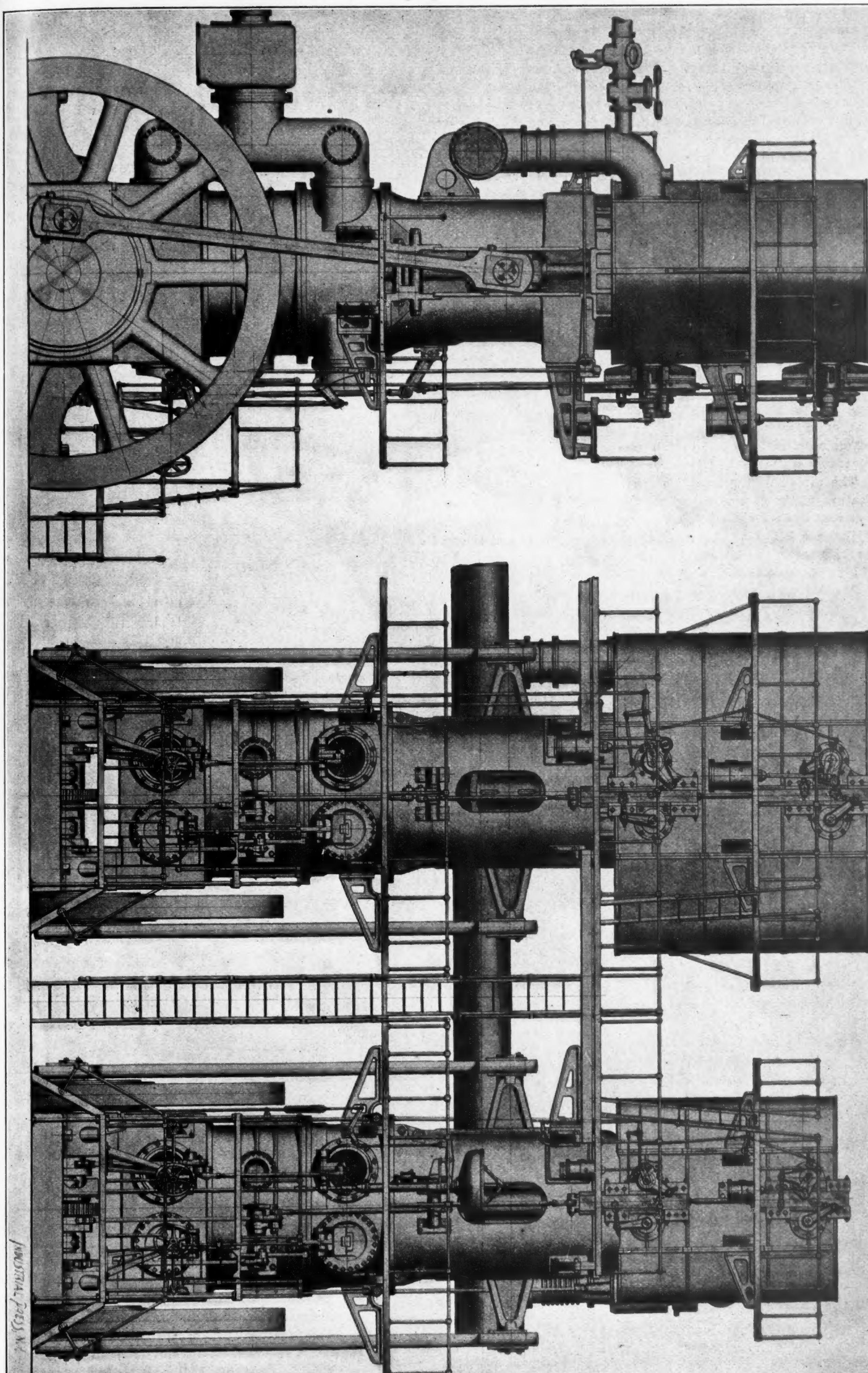


Fig. 5. 2000 H.P. Compound Blowing Engine. Steam Cylinders 50 and 96 inches in Diameter by 66 inches Stroke; Air Cylinders, 96 inches Diameter.

cylinder condensation. Lagging of the best grade of non-conducting metal is provided and the whole is covered with a steel jacket trimmed with corner angles. The cylinder heads contain chambers for Corliss type of valves.

The air cylinders are also of hard, close-grained air furnace iron. The walls are made sufficiently strong to act as the main column or frame work supporting the superimposed parts of the engine. A manhole is in the side and gives access to the interior of the cylinder to allow inspection and removal for repairs of the follower and packing ring, each of which is made in four pieces to facilitate these operations. Each head of the air cylinder is bored and fitted with two cast iron bushings or shells 27½ inches inside diameter, in which positively driven inlet and outlet piston valves operate. Two annular port openings with diagonal bridges are supplied in each shell. The air discharge chamber of each head is provided with a connecting pipe or elbow, and the two elbows unite to form a yoke or Y, terminating in a single outlet 28 inches in diameter, on which is attached a suitable check valve. There are automatic air relief valves in each head, set to operate at 35 pounds pressure. The air piston has two semi-cylindrical concavities running across it on both its top and bottom sides, which fit over corresponding convexities in the cylinder heads that contain the valve chambers. The whole outside surface of the piston head is machined, to reduce clearance at each end of the cylinder.

The air valves and valve motion constitute the most novel feature of the design of the engine. They are of the Kennedy horizontal double ported piston type. Both inlet and outlet valves are 27½ inches in diameter, fitted with cast-iron spring packing rings which were carefully re-turned after cutting the joint, the latter being protected by a keeper.

The inlet valves are operated by a simple harmonic motion through bell cranks. They open when the crank is slightly past the dead center, the piston having by this time traveled about one inch of its stroke, thus relieving whatever compression there may be in the clearance space. They close when the crank reaches the opposite dead center.

The outlet valves are worked by means of racks and sectors driven through a Corliss wristplate, and are arranged so as to give a quick opening and a very long dwell when closed. They are set to begin opening at the time the pressure has risen to 8 pounds per square inch in the cylinder. There seems to be no slip to these valves as they are very tight and close very rapidly.

This valve motion gives an indicator card at 15 pounds per square inch pressure, as nearly perfect as could be attained from an ideal poppet valve, and will operate within a range of from 6 to 20 pounds pressure, with a loss of not more than 1 per cent., due to the fixed point of valve opening, such loss being no greater than that in engines having the best type of poppet valve outlets.

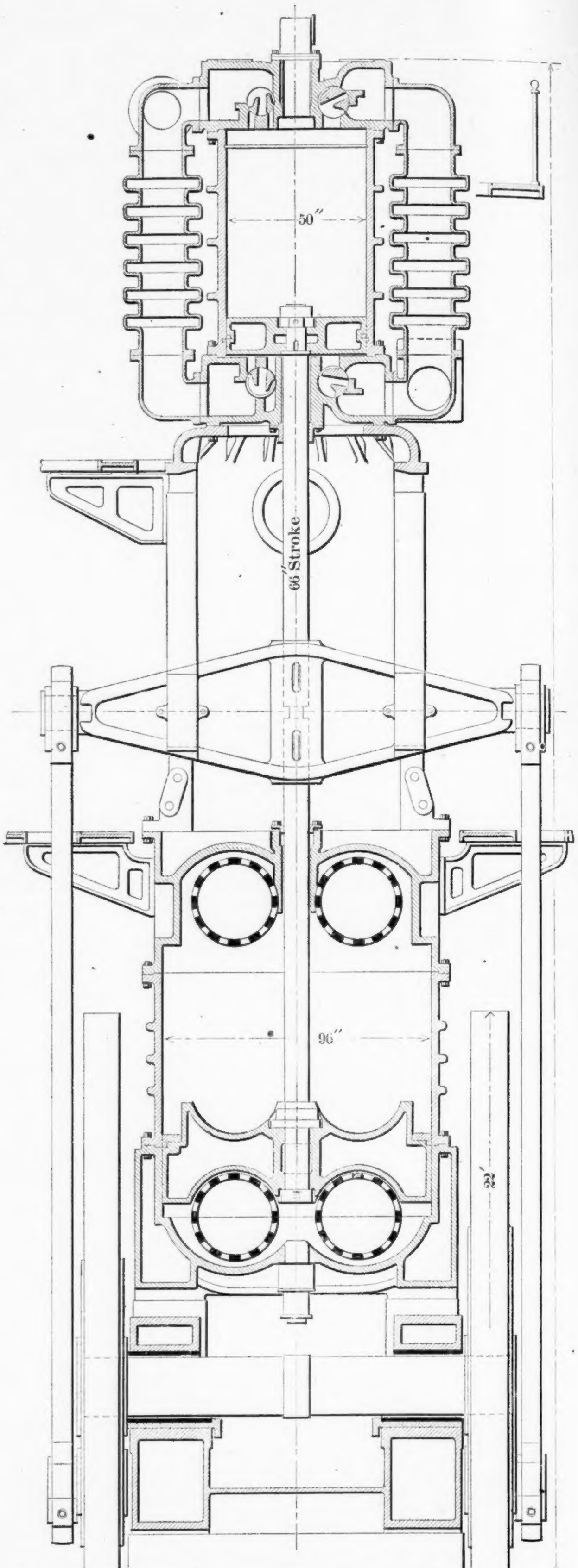
The whole valve mechanism is positively operated and receives its motion from a lay shaft located in the bedplate of the engine, and geared from the main shaft. This lay shaft is provided with cranks instead of with eccentrics to operate the valve motion.

The high-pressure engines are fitted with a Corliss automatic releasing valve gear for the steam cylinders. The steam valves are closed by dash pots. Each high-pressure engine has a governor of the fly-ball type, positively operated by gearing, and has a speed-adjusting device which may be shifted by hand and is of sufficient range to give a speed of from 25 to 50 revolutions per minute, all without stopping the engine. The low-pressure engine is supplied with Corliss trip steam gear adjustable by hand from zero to half stroke.

These engines have been in operation for about three months and although they have not yet run compounded, owing to the incomplete condition of the plants, they show highly satisfactory results as may be seen by the diagrams, Fig. 4, which were taken merely to check the accuracy of the valve setting.

The steam cards were taken from the high-pressure cylinder only, the low-pressure engine not being as yet operated condensing. The air cards were taken simultaneously with those steam cards by the side of which they appear.

It must be borne in mind in examining curves on the air diagrams that both the inlet and outlet valves are worked



Industrial Press, N.Y.

Fig. 5. Section through High-pressure Engine.

positively. At the points, x and y, where peculiar breaks in uniformity of the curves occur, the outlet valves are suddenly opened, and beyond these points the engine forces air directly into the air pipes. A number of irregularities appear in the delivery lines at points where the air cylinders of the other engines either begin to deliver air into the receiving pipes or cease to do so.

The total weight of the high-pressure engines is 610,000 pounds and of the low-pressure engines 685,000 pounds, and these weights are thought to indicate that the engines are the heaviest and most substantial of any blowing engines of their size so far constructed.

WROUGHT PIPE.*

ITS MANUFACTURE, CLASSIFICATION, STRENGTH AND CORROSION.

The development of the wrought pipe industry forms one of the great industrial achievements of the nineteenth century. It had its beginning about one hundred years ago, when the introduction of illuminating gas in England created a demand for pipe, which was promptly met by the manufacturers of gun barrels. The close of the long wars between England and France left on the hands of manufacturers large stocks of this commodity. These were converted into gas pipes by threading the large ends on the inside, and the small ends on the outside. They were easily connected by screwing the small end of one tube into the larger end of another.

The gas pipes of one hundred years ago were lap-welded by hand over a bar or mandrel. The process was slow and laborious.

The several steps were as follows:

1. Preparing a strip of iron of the required width, thickness and length.
2. Scarfing the longitudinal edges.
3. Heating to the proper temperature for bending.
4. Bending or rounding over a mandrel until the scarfed edges lapped.
5. Heating in a forge, a few inches at a time, to a welding temperature.
6. Slipping over a bar, and then hammering the lapping edges until welded.

The last two operations had to be repeated many times before the tube was completed.

The first decided advance in the manufacture of gas pipe was made in 1825, when James Russell, a manufacturer of gas tubes and gun barrels, discovered that a satisfactory weld could be made by butting and squeezing together the edges of a properly rounded and heated strip of iron. This was accomplished by means of a pair of semi-circular dies, slightly smaller in circumference than the width of the metal. As in the lap-weld process, the butt-welded tube was made by alternating heat and welding a few inches at a time.

Coincident with the invention of the butt-weld process of making pipe, Mr. Russell introduced the screw socket or coupling. This was an important step in the evolution of wrought pipe, since it permitted the sections to be made of uniform diameter from end to end.

Present Methods of Manufacture.

John Russell's method of butt-welding pipe was short-lived. It was soon supplanted by an improved process which consisted of drawing the prepared strip of metal, properly heated, through a circular die, thus welding the entire tube at one operation. This is the method of manufacturing butt-welded pipe at the present day, although, of course, many economic improvements have been made since its introduction seventy-five years ago.

The butt-weld process involves the following operations:

1. Clipping the corners of one end of a strip of metal, previously rolled to the required dimensions.
2. Heating to a welding temperature in the welding furnace.
3. Seizing the clipped end and drawing from the furnace with a pair of tongs, over which the operator throws a die or "bell" which drops into the bell holder; then connecting the handle of the tongs by means of a "hook" of special design, to a link of a moving chain which draws the strip through the "bell," thus welding it into pipe.
4. Delivering to a moving table, on which the pipe partially cools.
5. Feeding into sizing rolls, which shape and size to the required diameter.
6. Passing through straightening rolls.
7. Delivering to a slow motion shifting rack, and cooling.
8. Cutting off the ragged ends, and threading.
9. Screwing on couplings.
10. Testing by hydrostatic pressure.

With the development of steam engineering during the second quarter of the nineteenth century, came a demand for pipe of greater strength than the butt-welded pipe of that period. As the hand method of lap-welding was slow and expensive, the feasibility of making lap-welded pipe by machinery naturally occupied the attention of the more progressive pipe manufacturers. After a long period of experimenting, Messrs. Russell had the satisfaction of putting in successful operation, in 1835, the process of lap-welding, which (although somewhat modified and much improved) is used by the pipe mills of the present day. The operations are briefly as follows:

1. Beveling the edges of a strip of metal of the required dimensions.
2. Charging into the bending furnace.
3. Drawing from the furnace at a red heat through a die and over a mandrel, thus rounding the metal and over-lapping the edges. (For pipes of large diameters it is necessary to use bending rolls, similar to those used in boiler shops.)
4. Charging into the welding furnace.
5. Pushing from the furnace by means of a long rod, termed the "push bar," into the welding rolls. These rolls are grooved to correspond with the outside diameter of the pipe. A projectile-shaped mandrel held in position by a long bar, corresponds with the inside diameter of the pipe. As the pipe is drawn over the mandrel the rolls exert sufficient pressure on the laps to weld them. Each pipe as fast as welded is quickly disengaged by withdrawing the bar from the mandrel.

The finishing operations are the same as in the butt-weld process.

The great essential in the manufacture of welded pipe is a properly designed welding furnace, in which the skelp can be brought to a uniform welding temperature throughout its entire length. Next in importance is the personal factor. It is one man's business to see that the skelp is heated precisely to the proper point before it is taken from the furnace. If the temperature is below this point an imperfect weld results, and if overheated the metal is burned or hardened. It is another man's duty to inspect the pipe the moment it leaves the rolls, and to decide instantly and correctly whether the weld is perfect or otherwise. If imperfect the pipe is returned to the welding furnace, and is again passed through the welding rolls. These are responsible positions, and men who can fill them satisfactorily need not be out of employment.

Welded pipe is as small as one-eighth of an inch inside diameter, and as large as thirty-inch outside diameter. There is but one mill in the United States prepared to make the latter size.

This mill (which is now arranging to rebuild its entire plant at a cost of $10,000 000) contemplates making pipe of thirty-six-inch outside diameter as soon as the necessary equipment can be installed.

The minimum thickness of metal used in making lap-welded pipe is determined by the capacity of the tube to resist collapse when heated to the welding temperature. Standard casing and boiler tubes are close, if not quite, to the minimum thickness.

Lap-welding versus Butt-welding.

For many years the butt-weld process of making pipe was confined to the very small sizes, one and one-fourth inch being the maximum. During recent years, however, the process has extended to include larger sizes. At the present time it is the common practice among the pipe mills of the United States to make three-inch pipe and all smaller sizes by the butt-weld process, and larger sizes by the lap-weld process. This statement applies only to standard pipe, since the lighter classes of tubular goods can be made only by lap-welding. The strength of a butt-weld is dependent largely upon the thickness of the metal, and it would seem that the thicknesses adopted for standard pipe are very close to the minimum thicknesses that can be relied upon to give good results.

While it may be possible to make butt-weld pipe larger than three inches in diameter, the cost would greatly exceed

* Abstract of paper read before the Pacific Coast Gas Association, by Franklin Riffle, and published in "The Journal of Electricity, Power and Gas."

that of pipe made by the lap-weld process, and therefore manufacturers have fixed upon three-inch pipe as the maximum butt-weld size, purely for economic reasons.

The question is sometimes asked, "In what respect, if any, is lap-welded pipe superior to butt-welded pipe?" Manufacturers of exclusively butt-weld sizes of pipe assert that butt-welded pipe stands the mill hydrostatic test as successfully as lap-welded pipe, which is perhaps true. The severer test of actual use, however, under varied conditions, has established beyond a question the superiority of lap-welded pipe. Butt-welded pipe may give equally good service when the conditions attending its use are not unusual, but it should not be used for important pipe lines, if for no other reason than for its tendency to open at the weld when subjected to the excessive torsional or bending stresses which cannot be wholly eliminated in the work of laying, especially where tight joints are an important consideration. Therefore, because of its reliability for work of this character, manufacturers use only the lap-weld process in making line pipe.

Screw-joint Pipe.

With reference to weight, or thickness of shell, screw-joint pipe may be divided into four classes of standards:

1. Embracing standard pipe, line pipe, drive pipe and tubing.
2. Extra strong pipe.
3. Double extra strong pipe.
4. Casing.

Taking the weight or thickness of Class 1 as a standard of comparison, and representing it by 1, then extra strong pipe is approximately 1 4-10, double extra strong pipe 2 8-10, and standard casing 6-10; or if standard casing is represented by 1, standard pipe is approximately 1 2-3, extra strong pipe 2 1-3 and double extra strong pipe 4 2-3; in other words, standard pipe is nearly twice the thickness of standard casing, and about 1-3 the thickness of double extra strong pipe, of the same diameter. Classes 1, 2 and 3 have the same outside diameter.

The standard pipe of commerce, commonly known as merchant pipe, is of lighter weight than standard weight or full weight pipe. Manufacturers specify that the latter may have a permissible variation of 5 per cent. above or 5 per cent. below the nominal or table weights. Merchant pipe, however, such as manufacturers and jobbers carry in stock, is almost invariably under the nominal weight. The actual weight varies somewhat among the different mills, but usually lies between the limits of 5 and 10 per cent. below the table weight. Line pipe, drive pipe and tubing are *full* weight, subject to the "permissible variation" of the manufacturer. The same is true of extra strong and double extra strong pipe.

Drive pipe is used chiefly in oil wells, and is designed to stand heavy driving. The ends, therefore, are turned in a lathe, in order that they may meet at the centers of the couplings to form a continuous column, which can be driven without damage to the threads. As tubing is used in wells for pump barrels it is both plugged and reamed to insure a smooth interior.

The smaller sizes of double extra strong pipe are made by driving one piece of extra strong pipe inside of another. The larger sizes, however, are made in the usual way.

Standard casing is the lightest screw joint pipe that can be made. Casing which is made heavier than the standard is termed "special" casing. The increased thickness reduces the interior diameter. Thus the outside diameter of five-inch standard casing is 5.25 inches, and the inside diameter is 4.95 inches. The nominal weight is 8.20 pounds per foot. Three "special" weights of this size are made, weighing respectively 9.86, 12.80, and 15.88 pounds per foot. The corresponding inside diameters are 4.87, 4.75, and 4.65 inches, the outside diameter remaining unchanged. This arrangement permits the use of standard casing couplings and fittings for all the special weights of casing having the same nominal diameter.

Strength of Screw Joints.

The holding power, or shearing strength, of a screw joint is much greater than is generally supposed. When all the threads have the maximum contact, as in taper thread couplings, their combined stripping strength is several times the ultimate tensile strength of the shell of the pipe. This statement applies no less to the fine threads of casing than to the coarse threads of line pipe; but it does not apply to the ordinary straight thread couplings, such as are used on merchant pipe, since in practice the contact area of the threads is somewhat less than in taper thread couplings.

Taking for illustration two-inch line pipe, and assuming the threads to be in perfect contact, the total contact area approximates five square inches, while the metal area of the pipe is 1.07 square inches. Assuming the tensile strength of the metal to be 60,000 pounds, and the shearing strength to be 45,000 pounds per square inch, then the ultimate tensile strength of the pipe is 64,200 pounds, while the stripping strength of the joint is 225,000 pounds. This leaves a wide margin of safety for straight thread couplings, imperfect threads, or carelessness in making the joints.

Steel Pipe versus Wrought Iron Pipe.

The crowning achievement of the pipe industry has been the successful use of steel in the manufacture of wrought pipe. This innovation by one of the leading pipe mills in the early '80's, met with a storm of opposition, not only from rival mills, but from engineers as well.

It was represented that a perfect weld could not be made with steel, that steel pipe could not be threaded, and that it was even more unreliable and treacherous when under pressure than cast iron pipe. As late as ten years ago many engineers refused to accept steel pipe as a substitute for wrought iron pipe, although manufacturers were prepared then, as now, to prove its superiority. Since then engineers have so universally adapted themselves to new conditions that when an occasional non-conformist specifies wrought iron pipe in preference to steel, it is assumed that he has not kept pace with the wonderful progress that has been made in the manufacture of steel tubular goods during the last decade. At the present time manufacturers are producing a uniform quality of steel for pipe, that for malleability, ductility and weldability cannot be excelled by the more expensive product of the puddling furnace, while for tensile strength it is vastly superior to the highest grades of iron.

Many persons are deceived by the high-sounding phrase, "Guaranteed Wrought Iron Pipe." This class of pipe is seldom made of puddled iron. On the contrary, it is oftener made of re-rolled scrap, which contains a varying percentage of steel. If any one desires to satisfy himself regarding the sort of product that results from re-rolling a mixture of iron and steel scrap, such as is collected by junk dealers, let him inspect the fracture of an average bar of so-called "refined" iron. He will probably discover that a considerable portion of the area is crystalline in structure, and that the steel crystals and iron fiber have little or no affinity.

In 1897 Professor Henry M. Howe, an eminent authority on the metallurgy of steel, made a series of experiments for the purpose of determining the relative bursting strength, tensile strength, and frictional resistance of wrought iron and steel pipe. The information derived from these experiments is probably the most reliable and conclusive that has ever been compiled, relative to the comparative merits of iron and steel pipe. Three classes of wrought iron and steel pipe were selected, viz., two-inch line pipe, two-inch tubing, and five and five-eighth-inch casing.

The following table shows in condensed form the average results of the experiments upon bursting strength:

BURSTING TESTS BY HYDROSTATIC PRESSURE.

	Bursting Pressure Pounds per Square Inch.		
	2-inch Lead Pipe.	2 inch Tubing.	5⅝-inch Casing.
Wrought Iron, minimum	1000	3300	250
Wrought Steel, minimum	2300	5150	1450
Wrought Iron, maximum	4000	5000	1400
Wrought Steel, maximum	6000	6000	2750
Wrought Iron, average of all pipes tested	2918	4106	931
Wrought Steel, average of all pipes tested	4733	5800	2038

A comparison of the average results shows that the steel pipes excelled the wrought iron pipes by 62 per cent. in the

line pipe, 41 per cent. in the tubing, and 119 per cent. in the casing.

For making tensile tests short pieces were cut from certain of the steel and wrought iron pipes. These were accurately threaded and fitted with special extra heavy couplings. They were then pulled lengthwise in a tensile testing machine until they tore in two.

TENSILE TESTS.

	Tensile Strength, Pounds per Square Inch of Net Section.		
	2-inch Lead Pipe.	2-inch Tubing.	5⅝-inch Casing
Wrought Iron, minimum........	43,107	47,244	47,312
Wrought Steel, minimum........	63,025	60,370	75,931
Wrought Iron, maximum........	53,809	55,074	61,309
Wrought Steel, maximum........	67,586	66,495	91,591
Wrought Iron, average of all pipes tested	50,002	51,852	54,311
Wrought Steel, average of all pipes tested	65,999	63,057	82,355

The table shows that the steel pipes excelled the wrought iron pipes by the following percentages: Line pipe, 32 per cent.; tubing, 22 per cent.; casing, 52 per cent.

An objection that is sometimes urged against steel pipe is that it corrodes much more rapidly than wrought iron. Of late years this objection has been shown to be based on prejudice rather than fact.

As early as 1895 Professor Howe, in a paper entitled "Relative Corrosion of Wrought Iron and Steel," summed up his analysis of a considerable number of experiments made by himself and other investigators, in the following language: "It is misleading to say either that normal low carbon steel corrodes more or that it corrodes less than wrought iron, since the irrelative corrosion varies with the inclosing medium. I think we have every strong reason to believe that such steel when carefully made, resists corrosion in fresh water as well as wrought iron; in cold sea water, at least nearly as well as wrought iron and in acidulated water better than wrought iron." Five years later Professor Howe published the results of a series of experiments in which he exposed a number of plates of wrought iron, steel, and nickel steel, one-eighth of an inch thick, to the action of sea water, river water, and the weather for two periods of one year each. The results are summed up in the following table:

CORROSIVE TESTS.

	Sea Water.	Fresh Water.	Weather.	Average.
Wrought Iron	100	100	100	100
Soft Steel	114	94	103	103
3 Per Cent. Nickel Steel....	85	80	67	77
24 Per Cent. Nickel Steel....	32	32	30	31

No matter whether we use wrought iron or steel pipe corrosion is a factor that cannot be ignored. Its rapidity of action depends to a very great extent on the chemical properties of the soil in which the pipe is laid. More than thirty years ago the manufacturers of light riveted pipe in California realized that the success of this class of pipe depended upon the application of a satisfactory preservative coating. Judging from riveted pipes that were recently taken up in Oakland after having been in the ground since the early seventies, it was customary in those days to apply the asphalt coating very generously and with great care. Since then manufacturers of riveted pipe, refiners of asphaltum and engineers, have devoted much time and thought to this all-important subject, and at the present day the coating of steel pipe with asphaltum is probably better understood in California than anywhere else in the world.

In view of the importance of the subject the following points are suggested regarding the coating of pipe with asphaltum:

1. The pipe should be thoroughly cleaned. Every particle of rust, and as much of the mill scale as possible, should be removed.

2. The asphalt bath should be brought to a temperature of 300 degrees Fahrenheit. Its proper consistency may be determined by dipping in the mixture a strip of thin steel, and then withdrawing and plunging into cold water. If after this treatment the coating is soft and sticky the mixture contains too large a proportion of the fluxing or liquid grade of asphalt, and if in bending the strip the coating shows a tendency to crack and flake off there is an excess of the solid grade.

3. The pipe should be left in the bath until it has had sufficient time to attain the same temperature as the asphaltum. For the heavy types of welded pipe, it would be advisable to heat each pipe to the same temperature as the bath before immersing.

4. As a thick coating of asphaltum affords more thorough protection than a thin coating, two dippings are recommended, in which case the first coating should be allowed to harden before re-dipping.

5. Pipe should be coated in the vicinity of the laying. Under no circumstances should it be dipped before leaving the mill, except as a precaution against rusting en route, in which case it should be re-dipped at destination. After the pipes receive their final coat the greatest care should be exercised to prevent abrasion, both in distributing along the trench and in laying. As a final precaution every pipe should be rigidly inspected for abrasions, and wherever exposed, the metal should be given two coats of some reputable brand of asphalt paint.

Specifications.

Engineers sometimes prepare elaborate specifications for pipe without stopping to consider if they are practicable. So far as the quality of the material and the details of manufacture are concerned, it is always advisable to conform to the practice of the best pipe mills. All grades of steel, for example, are not equally weldable. Therefore it would be a waste of time to specify steel that could not be welded.

So far as testing the pipe at the mill is concerned the standard hydrostatic tests for the several classes of pipe will answer, unless extraordinary working pressures are contemplated. The standard tests are as follows:

Standard, extra strong and double extra strong pipe, two-inch and smaller, 300 pounds per square inch.

Standard, extra strong and double extra strong pipe, two and a half inch and larger, 500 pounds per square inch.

Line pipe, six-inch and smaller, 1,500 pounds per square inch.

Line pipe, seven-inch to twelve-inch, 800 pounds per square inch.

Tubing, 2,000 pounds per square inch.

Irrigation casing, five and five-eighths inch and smaller, 500 pounds per square inch.

Irrigation casing, larger sizes, 300 pounds per square inch.

Oil well casing, five and five-eighth inch and smaller, 600 pounds per square inch.

Oil well casing, larger sizes, 500 pounds per square inch.

Unless otherwise specified the several classes of pipe are tested at the mill to the above pressures. Arrangements can always be made for special tests when the pipe is to be used under high pressures. In no case should the mill test be less than one and one-half times the proposed static pressure.

Specifications for merchant pipe. The following specifications are sufficient to secure a good quality of merchant pipe at the ruling market price. Pipe to be made of good, ductile metal of uniform quality, and to be straight and smooth. Threads to be clean cut in accordance with manufacturers' standard. Couplings to be well screwed on. Jointers not to exceed 8 per cent. of the total number of lengths. All pipe to be subjected to the standard hydrostatic test before leaving the mill.

Specifications for line pipe. Pipe to be made of steel, of tough, ductile and uniform quality. Each length to be fitted with a full weight line pipe coupling, the ends of which shall be recessed. The threads of the coupling to taper uniformly from both ends to the center. A half-coupling thread protector to be securely screwed on to the exposed end of each length of pipe. None of the pipe to vary more than 5 per cent. above or 5 per cent. below the standard weights. Jointers not to exceed 6 per cent. of the total number of lengths. Each length to be tested at the mill to a specified hydrostatic pressure.

* * *

The *New York Times* in an article on post office oddities refers to the manufacture of stamps and tells its readers that the original steel plate bearing a stamp design, although *baked* as hard as a diamond, is never used for actual printing.

FLEXURE SIMPLIFIED.*

JOHN S. MYERS.

Most mechanics and even a few draftsmen, especially those engaged on machine tool work, know very little about the theory of flexure or strength of beams. They may know that the maximum bending moment in a beam uniformly loaded equals $\frac{\text{weight} \times \text{length}}{8}$ and that for a beam with concentrated load in the center, maximum moment equals $\frac{\text{weight} \times \text{length}}{4}$ because they have seen the formula in some book but could not tell you why such is the case; or if they had a problem the book did not cover, could not work it out. Moment of inertia, section modulus, radius of gyration and extreme fiber sound too scientific to them and seem too hard to tackle. As a matter of fact the whole thing is comparatively simple when divested of technical terms and put in a simple form.

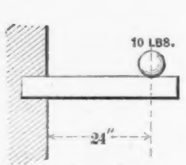


Fig. 1.

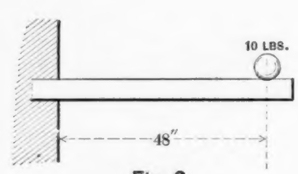


Fig. 2

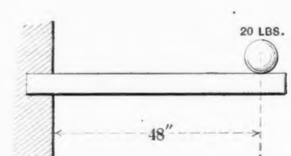


Fig. 3

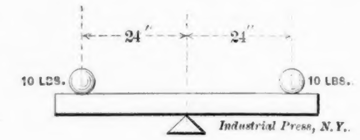


Fig. 4

The first thing we have to consider is moments. The word moment almost explains itself. It means importance, or of account, in ordinary talk, and in mechanics, when applied to a force, it means the importance of the force, with respect to bending; that is, it is a measure of the ability of a force to bend. A force of ten pounds at the end of a beam 24 inches long has a certain definite power to bend the beam. The same force 48 inches or twice as far from the support we at once say has twice the power to bend the beam. Twenty pounds 48 inches away from the support we would say had four times the power to bend the beam, for we have twice the load and twice the distance from the support.

The power of a force to bend is called a bending moment and is nothing more or less than the force multiplied by the distance from it to the point where we wish to determine its power. In Fig. 1, the bending moment at the support is $10 \times 24 = 240$ inch pounds. In Fig. 2, $10 \times 48 = 480$ inch pounds, In Fig. 3, $20 \times 48 = 960$ inch pounds.

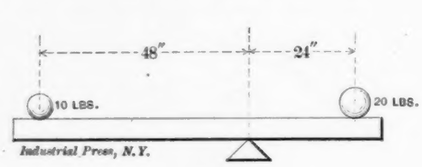


Fig. 5

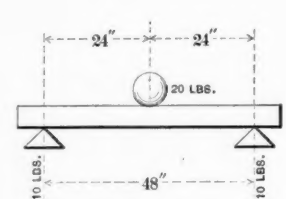


Fig. 6

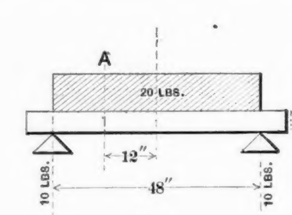


Fig. 7

Now we come to the principle of the *equality of moments.*

In Fig. 4 the beam is evidently balanced, as equal weights are equal distances from the fulcrum or point of support. The moment on the left is 10×24 and on the right 10×24. There is no tendency to move either way, so we say the beam is in *equilibrium*. In Fig. 5 the moment at the point of support for the force on the left is $10 \times 48 = 480$ inch pounds, and for the force on the right $20 \times 24 = 480$ inch pounds. The moments are equal so we see this beam is in equilibrium since the moments express the power of the forces to turn about this point. In Fig. 6 we have 20 pounds in the center and half of this or 10 pounds at each support. This force at the end, which acts upward, is called a *reaction*. The bending moment at the center of the beam is $10 \times 24 = 240$ inch pounds, just the same as in Fig. 1.

In Fig. 7 we have a reaction of 10 pounds upward at each end also, and the moment of this about the center is $10 \times 24 = 240$ inch pounds, but half the load on the beam, the center of which is at *A*, acts downward and has a moment in the other direction of $10 \times 12 = 120$ inch pounds. The net moment at the center then is $240 - 120 = 120$ inch pounds. This is what is called the *algebraic sum* of the moments. It is all the moments in one direction minus all the moments in the other direction on one side of the point under consideration, and expresses the power of all the forces to bend the beam at this point. By a similar method we may find the bending moment for any character of loading.

Now the beam must of course be able to resist the bending moment, and the power of a beam to withstand flexure is termed the *resisting moment*, which of course must equal or exceed the bending moment.

We will take the case shown in Fig. 8, where a force of 5,000 pounds acts in the center of a beam 200 inches long. The reactions are of course 2,500 pounds each, and the bending moment $2,500 \times 100 = 250,000$ inch pounds. All that portion of the beam above the line $y\,y$ is in compression and all that portion below $y\,y$ is in tension and at the center the stress is zero, as indicated by the arrows. This line $y\,y$ is called the *neutral axis*. Now if we divide the entire area of a cross section of the beam up into small parts and multiply the area of each part by the stress per unit of area at that point and then by its lever arm, x, we would have the resisting moment of the beam. This would be laborious, however, and it is the maximum stress at the outer edge called the *extreme fiber stress* that we wish to find. If we multiply each of these elementary areas by the square of its distance from the neutral axis $y\,y$ and take their sum we have the quantity called the *moment of inertia* and if we divide this quantity by the distance C we get the quantity called the *section modulus*. Section modulus may be said to be the area equivalent to the total area of the section if concentrated at the extreme fiber and multiplied by its lever arm. We readily see that this equivalent area times its lever arm, when multiplied by the stress per unit of area equals the resisting moment of the beam; or in other words, section modulus $\times$ stress = resisting moment, which is also equal to the bending moment or $ZS = M$ where Z = Section modulus, S = unit stress and M = bending moment. As we have seen before, $Z = \frac{\text{moment of inertia}}{C}$ usually written $\frac{I}{C}$. The section modulus Z for different shapes has been worked out to simple formulas; for a rectangle like beam in Fig. 7 the formula is $Z = \frac{BD^2}{6}$. Now to find the size beam for conditions in Fig. 8, we take our formula $ZS = M$ or $\frac{M}{S} = Z$ and inserting the values of M and S, allowing say 1,000 pounds per square inch for S, if a pine timber, we have $Z = \frac{250,000}{1,000} = 250$. But for a

* This simple explanation of the flexure of beams is to assist the younger readers in the use of this month's data sheet.—EDITOR.

rectangle $Z = \frac{BD^2}{6}$, so $\frac{BD^2}{6} = 250$ or $BD^2 = 250 \times 6 = 1{,}500$.

Now we can assume some breadth and figure for the depth or assume some depth and figure for the breadth. If we took a beam 10 inches deep, it would have to be $\frac{1{,}500}{10^2} = 15$ inches wide; if we took a beam 12 inches deep it would have to be $\frac{1{,}500}{12^2} = 10.42$ inches, say a 12-inch by 10-inch timber. If we wanted to use an I-beam with a stress of say 16,000 pounds

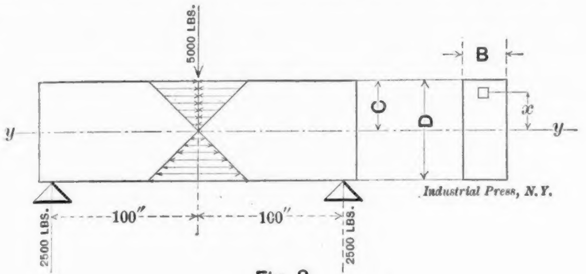


Fig. 8

per square inch for dead load, we would get $Z = \frac{M}{S} = \frac{250{,}000}{16{,}000} = 15.63$, and from tables in the handbooks of steel concerns we see that an 8-inch, 23-pound beam or a 9-inch, 21-pound beam would answer the purpose. The foregoing simple application should be enough to start one on the right track and the writer hopes it may be of use to someone struggling for the truth under adverse circumstances.

* * *

DOUBLE-ACTING PUMP.

Editor MACHINERY:

The pump illustrated in your issue of October, 1903, page 90, is a hoary old friend of mine. As your correspondent states that W. H. Wilcox & Co., of London, England, have been exhibiting it lately it might be well to correct the probable impression that it is new.

Thirty years ago I was engaged in steam pump building and patented several improvements; so I was interested in finding the simplest double-acting pump possible. Some time afterward, but more than twenty years ago, I proceeded to build a pump—intended to be the limit of simplicity—as follows:

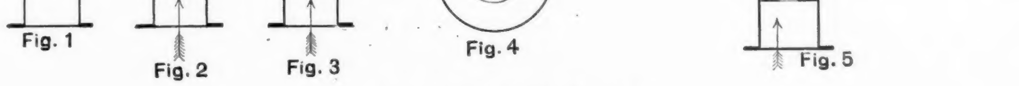


Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5

Simple Double-acting Pumps.

Let *A* be a piston in a simple piece of pipe, Fig. 1. If *A* is moved upward as per arrows we have a pump, but only till the piston reaches the top end of the pipe. Now, it becomes necessary to take a new hold of the water, but there is nothing to hold up the column while this is being done. I then evolved the arrangement, Fig. 2, putting in two pistons, *A B*, in each of which there is a valve opening upward and imagined that while *A* is going down *B* is coming up, and *vice versa*. In other words, the pistons, *A*, *B*, approach *to* and recede *from* each other alternately and a solid stream is discharged. I then put stirrups on the pistons, as in Fig. 3, and used two opposite eccentrics on center shaft, *C*, connected with the pistons, as shown. This I built and tested and found to work better at high speed than any double pump I ever saw.

At no period of my life did I ever feel so certain that I had the material for a fundamental patent; so my application was at once sent in. It would be safe to say that no enthusiastic inventor ever got a more beautiful reference from Washington, for the office sent to me a complete drawing of my model with two cranks instead of my two eccentrics—patented in 1860 (No. 27,945)! Applying this old claim to Fig. 3 it would read thus: "The shaft, *C*, its two cranks, in combination with the two connecting rods and the valved buckets, *S S*, and their valves—so that a simultaneous reciprocating motion, in contrary directions, may be imparted to the said buckets, *S S*, by the rotation of the shaft, *C*, and so that the two barrels may be in direct line with each other." "Bucket" is the old name for a piston containing a valve. The "Wilcox" drawing is substantially the same as the drawing in this old patent. In 1857 (No. 17,625) a modification appeared as per Fig. 5, shaft *C* having a simple crosshead, as shown. Outside the case was placed the lever, *H*, to be moved through any convenient angle, by hand, as indicated by the dotted lines. This pump, in whatever form, with the "motion" working in the water, is not of much practical value and is only good when bent into a U, as in Fig. 4, and the two pistons operated in the same direction from a crosshead, *D*, common to both. For this successful form see MACHINERY, August, 1899, page 367. But to *all* these forms there is a fundamental objection. Assume that the displacement by one of the pistons, while its valve is seated, is x: then through the other piston, during the same time, $2x$ of water must pass. In other words, when any one of the pistons is taking water through its port (or valve) it is *meeting* a stream of its own velocity in the opposite direction. It is not usually evident at first glance that the action of pump, Fig. 4, is the same as Figs. 3 and 5, yet such is the fact.

JAMES ARTHUR.

The Arthur Co., New York.

* * *

NILES FORTY-TON TRAVELING YARD CRANE.

A cut given on next page shows the latest type of an improved and economical apparatus for the handling of heavy and bulky freight in a railroad yard. The view shows a portion of the yard of the Buffalo & Allegheny Valley Division of the Pennsylvania Railroad Company, at Buffalo, N. Y., and includes a four-motor Niles overhead electric traveling crane, 48 feet span, and a substantial structural steel runway 40 feet long. The crane spans three tracks, and leaves a wide passageway which gives ample approach for teams and trucks on one side of the cars covered by this apparatus. The height of the runway gives the main hook a lift of 24 feet. The motor operating the main hook is 30 horse power.

In addition to the main hook, a quick running auxiliary hook of 5 tons capacity, driven by a 21 horse power motor, is provided for the rapid and efficient handling of light loads, which performs by far the greater part of the service of the crane. The bridge consists of two heavy curved girders, of box section. It is driven longitudinally on the runway by 30 horse power motor located on the front girder which is geared to the truck wheels on either side, the motion being controlled by a foot brake located in the operator's cage which acts directly upon the armature shaft of the motor. A foot bridge is provided the entire length of the span, with customary guard rail. The bridge trucks are of built-up type, securely fastened with the utmost rigidity to the girders, provided with heavy cast steel double flanged truck wheels with treads accurately finished to uniform diameter.

The trolley, traversed on the bridge by a 7½ horse power motor, is the standard type used on overhead cranes, consisting of heavy side frames securely bolted together and kept in perfect alignment by a separator. All the gearing is cut from the solid, and runs encased in oil, which gives the entire mechanism an unusually high mechanical efficiency. Both hoists are provided with mechanical and electric brakes, also circuit breakers and limit switches to prevent overwinding and consequent damage to the crane or its load. The trolley, operator's cage, and bridge drive motors are of the inclosed type, affording suitable protection from the weather. The runway, it will be noticed, is of substantial construction. It consists of four built-up columns carrying runways of riveted plate and channel construction, laterally braced by overhead struts and chords of lattice construction. The speed of the main hook lifting full load is 9 feet per minute; light, 18 feet. Auxiliary hook, full load, 50 feet; light, 100 feet. Trolley travel across bridge, with full load, 80 feet; light, 100 feet. Bridge, full load, 225 feet; light, 275 feet.

Yard Crane in Use by Pennsylvania Railroad at Buffalo.

It will be readily appreciated that an equipment of this character has a much greater capacity than the average pillar or swinging crane which, where any is in use, is usually installed at railroad freight stations. If at any time it is desired to cover increased acreage with the hook, the length of runway is readily increased by adding additional spans. This crane is notable because of the extra height of lift, 24 feet, which enables the loaded hook to clear the top of box cars or other obstructions while performing the functions of its regular service of loading and unloading.

The complete apparatus was manufactured, installed and erected by the crane department of the Niles-Bement-Pond Company, Meadow and Mifflin Streets, Philadelphia, Pa.

* * *

In annealing cold rolled steel, gas is turned into the annealing boxes after they are removed from the furnace. The burning of the gas uses up any air that might come in contact with the steel while cooling. By this method the steel comes out of the boxes in bright condition.—*Sparks from the Anvil.*

HYDRAULIC INSTALLATIONS.

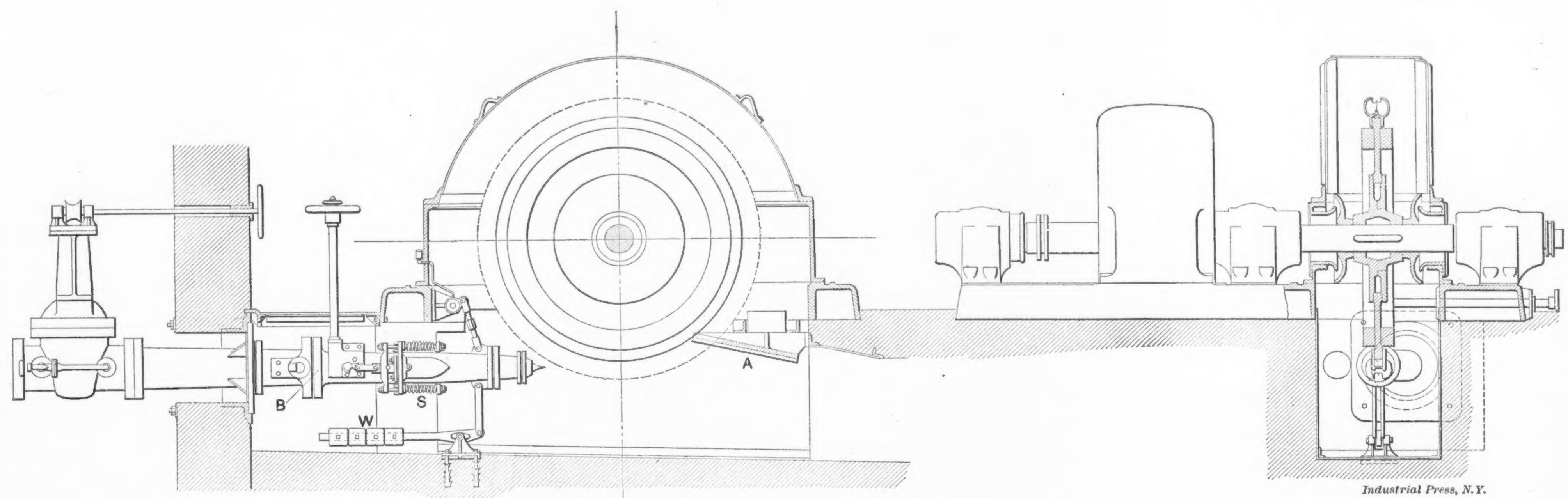
REMARKABLE WATER POWER ON THE PACIFIC COAST.

Recent development in hydraulic practice on the Pacific coast has been in the tendency of the utilization of higher heads. In the minds of a number of engineers the question has arisen as to the wisdom of developing these high heads, utilizing the totality of fall in one station, as against dividing the fall up and passing the water through two or more stations in series, in this way utilizing the same water under lower heads in two or more power plants.

The Edison Electric Company, of Los Angeles, had this problem to consider when it was proposed by them to install their new power plant, which has been known as Mill Creek No. 3 being located in the Mill Creek Canyon, near Redlands, Cal. The effective head on this plant is 1,912 feet. After carefully considering the matter the Edison Company decided that it would be better engineering to utilize the total available head in one power station, although it is the highest or greatest head it has ever been attempted to utilize in this manner. Water falling from a height of 1,900 feet would theoretically have a velocity of flow of over 20,000 feet per minute and it would be necessary for a tangential water wheel to have a peripheral speed of nearly half this velocity; as a matter of fact the wheels now running in this plant have a peripheral speed of between 9,000 and 10,000 feet per minute, or upward of a mile and three-quarters a minute.

The plant to be installed was to consist of four water-wheel generating units of 750 kilowatts each, designed for a 25 per cent. overload, at a turning speed of 430 revolutions per minute. They therefore decided to install at first but two units, the balance of the plant to be placed after tests had been made in the first two wheels. Accordingly they placed an order for one unit with the Pelton Water-Wheel Company, San Francisco, and one with the Abner Doble Company, San Francisco, makers of the ellipsoidal tangential water-wheel.

We are informed by the Abner Doble Company that the balance of the equipment for this station was finally purchased



Tangential Impulse Wheel for Operating under the Highest Head yet Utilized—1912 feet.

from their firm and they have kindly furnished us with particulars about this and other important installations of the Doble ellipsoidal tangential wheel, together with a blueprint of one of their Mill Creek wheels direct-connected to an electric generator.

The Doble wheel installed at the Mill Creek station showed an efficiency on the preliminary tests of from 80 per cent. to 84 per cent., at loads ranging from one-half load to 25 per cent. overload. The installation is of particular value in confirming the wisdom of the Edison Electric Company in utilizing their total head in a single station as against dividing it up over several stations, as has been done by several other companies. It is demonstrated by the tests at this plant that the efficiency to be secured from tangential wheels under these very high heads is exceedingly favorable, clearly showing that it is safe to utilize the total available power value in one station. These tests make an interesting comparison with the work of one of the famous Swiss builders in the Vouvry plant, where the efficiency was only 56 per cent.

The illustration on this page of one of the Mill Creek wheels shows a 1,300 horse power wheel with needle regulating and deflecting nozzle designed to operate under an effective head of 1,900 feet. The generator base plate is extended to carry a third bearing for the electric unit and the housing of the water-wheel. The water wheel itself has a diameter of 7 feet 8 inches, and one single nozzle is applied, furnishing a stream of 2 inches maximum diameter. The wheel body is of the composite type, a steel disk being clamped between the hub and follower plate, and carrying two heavy cast steel flywheel rings, rigidly bolted to it.

The nozzle is of the deflecting needle regulating type, the regulating needle being operated by hand by means of a hand wheel with worm-gear attachment; whereas the Lombard governor used for regulating the wheel, but not shown on the drawing, deflects the nozzle and turns the stream down into the tail race, partially or entirely away from the buckets, according to the load on the generator. The regulating needle in this case has the purpose to increase the area of jet during periods of peak load, which occur in the evening, when to the normal load considerable load is added on account of lights being switched in.

The power station furnishes the light and power for Redlands and Los Angeles and smaller places between, a considerable part of the power being used to operate centrifugal pumps to irrigate citrus groves in that part of the country.

The engraving shows how the connection is made with the gate valve outside of the power house, the operating spindle going through the wall in such a way that the operator has both the handwheel for the gate and the handwheel for setting the needle within easy reach.

The sectional end elevation at the right corner of the drawing also shows the centrifugal water guards applied to avoid stuffing boxes, which cause unnecessary friction. These water guards serve the double purpose of preventing splash water escaping from the housing, and at the same time ventilate the housing to maintain an easy flow of water in the tail race. The casting shown in the front elevation of the drawing is a baffle plate, through whose opening the buckets pass. The purpose of this baffle plate is to shave off the last particles of discharge water emanating from the buckets.

The needle, by which the size of stream flowing through the nozzle is regulated, has a long stem extending back longitudinally through the body of the nozzle. At the forward end the stem is enlarged and formed into a cone which, by the longitudinal movement of the needle, opens or closes the mouth of the nozzle. The spiral springs, *S*, at the side of the nozzle, are to equalize the varying pressure on the needle cone in the different positions of the needle or at different nozzle openings. The needle stem is provided with a balancing plunger which extends into the pressure chamber of the nozzle body and balances the needle at normal opening.

When the needle is entirely drawn back or the nozzle full

open, the pressure on the springs is released as the pressure on the balancing plunger and the forward pressure on the needle bulb are equal. By shutting the nozzle or moving the needle forward in reducing the area of the issuing jet the reaction decreases, whereas the forward pressure remains the same. To make up for this variation, the compression springs are provided, which are fully compressed when the needle is entirely closed and in which case the forward pressure on the bulb is a maximum. On account of this it takes the same power to operate the needle wherever its position might be.

As stated at the beginning, the Mill Creek plant, of which one of the power units is shown in the illustration, is operating under the greatest head of any similar plant in the world, and it will be of interest to add a few facts about the impulse wheels recently built by the Abner Doble Company, for use in connection with the Bay Counties transmission system, which are the largest impulse wheels ever constructed, so far as we are aware. Last summer two wheels were installed at the Nimshaw Power House of the Valley Counties Power Company, a sub-company of the California Gas and Electric Corporation, and feeding into the transmission line of the Bay Counties Power Company. These two machines have now begun operation.

The power house is located in the Butte Creek Canyon, twenty-four miles from Chico. The available total head of water is 1,531 feet, taken down in one pipe line 6,200 feet long, and tapering in three sections, from 30 to 28½ inches diameter. Within the power house the pipe terminates in a Y, each branch of the Y supplying a 3,700 horse power water-wheel, the largest wheels operated as yet by one single jet of water.

The generators are of the Stanley Electric Company's make, the rotary element mounted on one single shaft with the water-wheel; the entire hydro-electric unit runs in two bearings, the rotary element of the generator between the bearings, and the water-wheel overhung. Shaft and disk are nickel steel forgings, made by the Bethlehem Steel Company, the shaft being hollow-forged and oil-tempered, and the buckets are steel castings of the ellipsoidal type. The total weight of the revolving part of each unit is over forty tons; the speed 240 revolutions per minute.

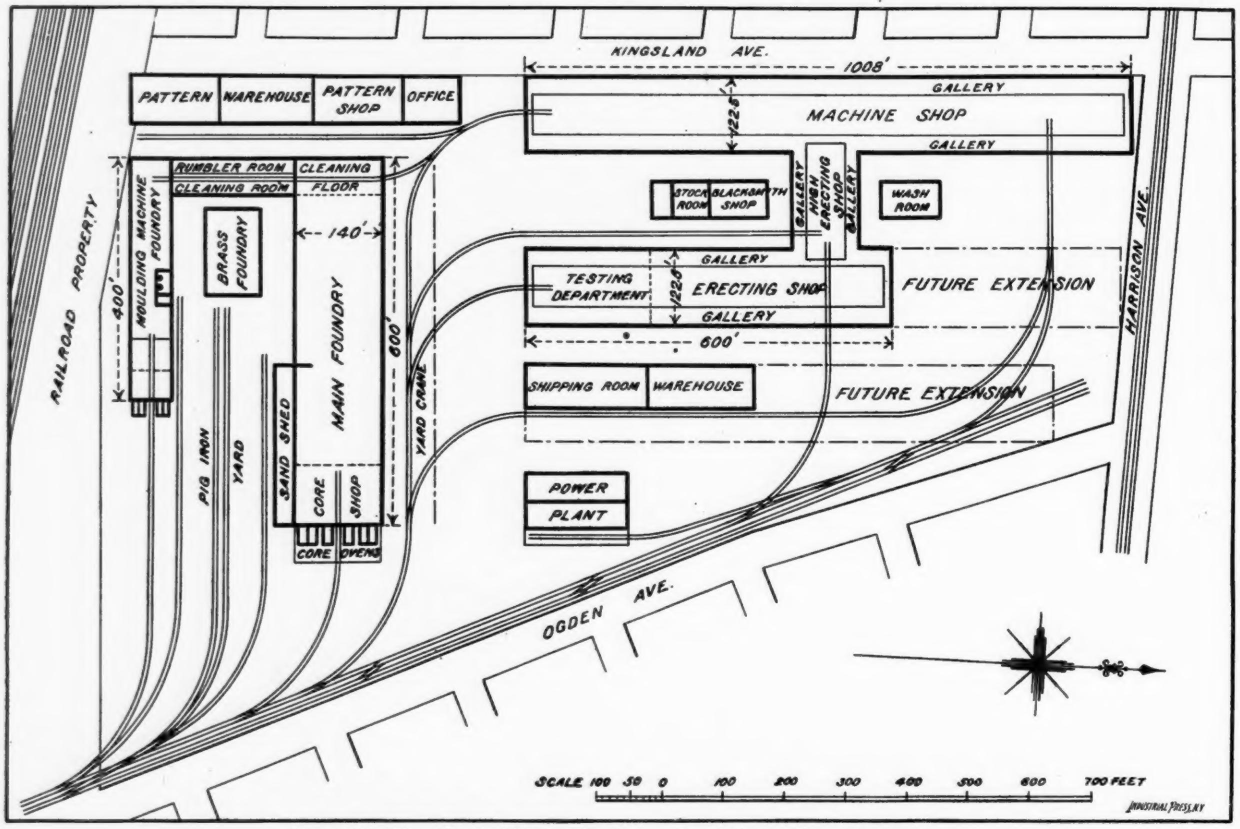
The Abner Doble Company is now building, however, a unit of 7,500 horse power to operate under the same total head of 1,531 feet, for the Bay Counties Power Company, which thus considerably beats their own record. It will be direct-connected to a Stanley Electric Company's alternator, and will run at a speed of 400 revolutions per minute, the entire hydro-electric unit being mounted on two bearings and one single nickel steel shaft. The wheel takes water from a single nozzle.

* * *

THE NEW WORTHINGTON PLANT.

An extensive pump manufacturing plant, the largest in this country and probably in the world, is now under construction at Harrison, N. J. It is to be occupied by the firm of Henry R. Worthington, who employ about 3,000 men in their present works at South Brooklyn, L. I., and Elizabethport, N. J. The new plant at Harrison covers an area of about 30 acres, facing Harrison avenue, and will employ from 4,000 to 5,000 men. The total cost will be in the neighborhood of $2,000,000.

It consists of a main machine shop with side galleries over 1,006 feet long, an erecting shop 592 feet long and of the same section as the machine shop and a high erecting shop 210 feet in length and four galleries in height in the side bays connecting the two shops. The main foundry is 600 feet in length and there is also a special foundry for small work, 410 feet in length, with a building 200 by 60 feet in size, for cleaning castings, connecting the two. The pattern building is four stories high and 550 feet long, and is divided by fire walls into four sections. The north section will be used for offices and drafting rooms, the adjoining section for the pattern shop and the balance of the structure for pattern storage. The power house, which will be equipped with the best modern boilers, engines and generators, is a building 172 by 102 feet. Five generators are to be installed having a total capacity of 2,500 kilowatts. Electric power distribution is to be employed throughout, and the grounds will be illuminated by electric arc lights. There are many other buildings which will be used for packing, storing and shipping goods, etc. The buildings are so arranged that additions can be built when the work demands it. All will be connected by a complete system of railroad tracks entering the ends of the buildings and placing the works in direct communication with the Delaware, Lackawanna & Western, the Erie and the Pennsylvania railroad systems. The new plant will be devoted entirely to the manufacture of water works machinery, water meters, cooling towers, condensers, feed-water heaters, centrifugal pumps and steam pumps of all kinds. It is expected that at least three of the buildings will be ready for occupancy about January 1, 1904.



Plan of the Worthington Plant of the International Steam Pump Company.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

Beginning with the January, 1904, issue the name of *Feilden's Magazine* will be *The Engineering Review*.

In a paper on foundations read by Mr. George B. Francis before the Boston Society of Civil Engineers, February 18, 1903, some elementary information on permissible loads per unit of area were given as follows: Ledge rock, 36 tons per square foot; hard pan, 8 tons per square foot; gravel, 5 tons per square foot; clean sand, 4 tons per square foot; dry clay, 3 tons per square foot; wet clay, 2 tons per square foot; loam, 1 ton per square foot.

The gross earnings of the railways in the United States for the six months ending June 30, 1903, were the largest in the history of railroading in this country. The increase in gross earnings for this period was over $90,000,000, and of the net earnings, somewhat less than $20,000,000. The increased cost of operation due to higher wages, and of fuel and other supplies, have had the effect of keeping the increase of net earnings down to a little more than twenty per cent. of the increased gross earnings.

The extending use of aluminum for electrical purposes and the wide prospective use for it in the manufacture of thermit, makes the report that a St. Louis man has discovered a pyrochemical process of manufacturing aluminum from clay of considerable interest, especially so as he claims the metal will be greatly cheapened by the new process. The process, discovered by Mr. Schwahn, is claimed to effect the reduction in much shorter time than now required and to reduce the cost from $500 to $100 per ton.

A somewhat novel plan for balancing a loose pulley is described in the *Woodworker*. After the pulley has been bored out ready for use, place it upon a smooth arbor that is solidly supported in place. Wind a cord around the hub, or the rim, according to size of pulley, and give the cord a long, even pull, that unwinds it, giving the pulley the motion due to unwinding process. The inner end of the cord is not tied to the pulley, but left free, except that the cord crosses it to hold the same in place. When the pulley is perfectly balanced it will run a long time without "chattering."

The Ellwood Ivins Tube Works mills at Oak Lane Station, Philadelphia, have succeeded in producing tool steel seamless tubing. The tubing is made in sizes from about 2 inches in diameter down to small sizes of 1-64 inch, in all thicknesses of walls. The tubes are most accurately drawn both as to internal and external diameters, and have a polished surface. So great is the precision that it is claimed that no work is required for fitting the tubes after they are made in sizes ordered. It would seem that this new product in tool steel would eliminate the necessity of boring out solid rods or bars where either short or long hollow articles were required, such as cutting dies, bushings, drills, etc. These steel tubes take a high temper at low heat.—*Iron Age*.

The largest circular saw in the world has just been turned out at the works of Henry Disston & Sons, in Philadelphia, for use in the lumber section of Elk county, Pennsylvania. The saw is 7 feet 4 inches diameter and bears teeth each one of which is 4 inches long. The saw weighs 305 pounds. The purpose for which the mammoth saw was made is of interest. It will be used to cut pine stumps into shingle bolts, thus opening to the market a vast quantity of material which until recently was considered useless. In Elk county, where thirty years ago the forests of white pine were hewn down and turned into lumber, are thousands of acres of great pine stumps as solid as the day the trees were cut. Many of these stumps stand from 5 to 8 feet above ground, so that in the swampy regions of the Elk county plateaus there are millions of feet of choice shingle wood.—*The Woodworker*.

A German casehardening process described in a recent consular report by Consul-General J. O. Hughes, Coburg, Germany, employs phosphorus in connection with the other ingredients of the pack, to impart a greater hardness. The effect of the phosphorus is said to be to weaken the coherence of the surface particles of the iron and to thus facilitate the absorption of carbon. The pieces to be casehardened are packed in cast-iron boxes in the ordinary manner, the cover being tightly closed and luted with clay. The pack consists of bone dust, yellow prussiate of potassium, cyanide of potassium and phosphorus. An example is quoted to show the proportions. To caseharden pieces weighing say, 400 pounds, 300 grains of yellow prussiate, 250 grains of cyanide and 400 grains of phosphorus are mixed with the necessary amount of bone dust to properly and economically harden the work. It is said that the surface hardness obtained by this process is phenomenal.

An accident, illustrating the danger of not having main valve connections carried through to the upper decks of steam vessels, occurred to the *Picqua*, October 10, off the American coast during a heavy storm. The main steam pipe broke off close to the cylinder, filling the engine room with scalding steam and causing the death of two men. For two hours the vessel rolled at the mercy of the seas, the engines having stopped, and the steam still pouring through the broken pipe until the fires were finally extinguished. At last it was possible to enter the engine room and effect a temporary repair of the broken steam pipe, so that the vessel could proceed. Had there been connections to the main steam pipe valves from the upper decks, the danger of the accident would have been greatly minimized and perhaps the lives of the men saved. Connections to all important valves from the upper decks is one of the details that Uncle Sam looks after very carefully in the design of the navy vessels.

In his "Engineering Reminiscences," November *Power*, Mr. Charles J. Porter says that the firm of Smith & Coventry, Manchester, first introduced the plan of using inserted tool holders for lathe and planer work, thus saving the time of the men spent loafing in the blacksmith shop waiting for tools to be dressed. This firm also adopted the plan of grinding the tools to fixed angles, having one boy who did nothing else but collect tools, grind them while held in a suitable fixture, and return them to the men. In the same connection Mr. Porter says that in this shop he picked up the idea of the solid wrench having the sides of the jaws at an angle of 15 degrees with the handle, by which expedient it is possible to turn a hexagon nut in close quarters, as is now well known. Upon his return to the United States in the late "sixties," wrenches made on this plan were furnished with the Porter-Allen engines, and the J. H. Williams Co. soon commenced their manufacture here.

It is well known that water under pressure will leak through joints that appear (and are) perfectly tight with steam pressure. In the language of the pipe-fitter, steam pipe joints have the property of "taking up," that is, small leaks are self-sealing. Prof. Ewing calls attention to the fact that this property applies to superheated steam to a greater degree inasmuch as the presence of water of condensation is impossible, which is not the case with saturated steam. In the cylinder of a saturated steam engine in good condition there is always a certain amount of leakage past the piston and valves, represented almost entirely by the water of condensation which collects in films and slips by the closest fitting surfaces—in small quantities, it is true, but representing a vastly greater volume of steam. But with superheated steam this trouble vanishes since with a large ratio of expansion there is little or no cylinder condensation. This is not stating, however, that a whole troop of other mechanical troubles are not introduced, which are of much greater difficulty and importance.

Several years ago Mr. George Westinghouse, we believe, first called attention to the great increase of distance required for the stopping of high-speed trains after the brakes are applied, over the distance required for stopping trains running at ordinary speeds, say, 35 to 45 miles per hour. The distance required, with the same braking effect, is theoretically as the ratio of the squares of the two speeds. That is, if it requires a distance of 400 feet to bring a train running 40 miles an hour to a dead stop after the airbrakes are first applied, a distance four times as great, or 1,600 feet, would be required, theoretically, for the same train running at a speed of 80 miles an hour. Therefore we are not surprised to learn that in the high-speed tests on the Marienfelde-Zossen experimental railway the car ran fully a mile after the brakes were applied. The maximum speed was, it will be remembered, something over 130 miles per hour.

In dealing with slowly-moving mechanism, it is easy to determine by observation the exact motion of the different elements constituting the machine. At high speed this is less easy, and where cams are made use of for actuating certain parts, it is impossible to find out what happens at high speeds from observations made at low ones, since the inertia effects only become of importance when the speed is great. A method of observing the motions of rapidly-moving parts, such as, for instance, the opening and closing of the exhaust valve motion of a high-speed petrol motor was described by Professor Hospitalier at a recent meeting of the Paris Society of Civil Engineers. In principle the plan consists in illuminating the valve motion in question by flashes of intermittent light. If these flashes occur regularly at every cycle of the motor the valve gear will appear quite stationary, while if the periodicity of the flashes is slightly decreased, the motion will appear to run through its complete cycle, but at a very slow speed, and in so doing every vibration it makes will be clearly observable. An instrument specially designed for researches of the kind in question has been constructed for M. Hospitalier by Messrs. Malicet and Blin, of Paris.

In a paper read by Charles F. Burgess before the American Electrochemical Society at Niagara Falls, N. Y., September 18, 1903, he told how the passive state of iron is successfully used to permit the removal of spelter from the outside of brazed joints. Iron has the peculiar property of going into a passive state when employed as the anode in suitable electrolytes—sodium nitrate and other soluble nitrates being examples. When in the passive state the iron is no longer attacked by the anode products, the iron acting the same as an anode of platinum. This peculiar property has been only recently utilized for removing spelter, the demand for such a process having arisen with the "dip" process of brazing used in bicycle manufacture. In this process the joints of the frames are dipped into a crucible of melted spelter, covered with a suitable flux. The spelter not only enters the joint, but adheres to the exterior of the frame and has to be removed before the frame is enameled. The ordinary process is by laborious filing, but this is now being rapidly superseded by the electrolytic stripping process, the spelter being dissolved off in the bath without affecting the iron or steel frame. The process not only saves considerable labor, but avoids the danger of damaging thin tubing by file scratches, etc.

From the daily consular report No. 1802 we learn of a new armored concrete flooring manufactured in the shape of beams ready for use by three factories in Germany, three in Russia, and one in Italy, operating under the Siegwart patent; also by the Siegwart Beam Company of Lucerne, Switzerland. These beams are made hollow for the sake of lightness and generally have six iron rods ranging in size from .197 to .394 inch diameter, according to the size and span, imbedded in their walls. They have a uniform width of 9.84 inches and are made 3.5, 4.7, 5.9, 7.1, and 8.4 inches high, according to the span and load. The beams are not made singly, but in breadths of about 8 feet, which are cut up into slices before the cement has set, by means of a special machine. The hollow spaces are formed by iron cores so made that they may be contracted by turning a screw, and thus allow their easy removal after the concrete has partially hardened. The concrete is made in the proportion of one part of cement to four parts of coarse sand. In addition to being used for floors the Siegwart beams may be used for terraces, roofs, walls, pavements, etc. Being hollow they prevent excessive radiation of heat, making buildings warm in winter and cool in summer, and the hollow spaces may be used for hot air conduits if so desired.

RECORD FREIGHT RUN.

New York Central officials recently made public the running time of a freight train loaded with export cotton, which it was said holds the freight record between Montreal and New York. The train made the 435 miles between Valleyfield, Quebec, and New York in 16 hours and 20 minutes. Two hundred bales of Egyptian cotton were in store at Valleyfield, a few miles south of Montreal. They had been sold to Liverpool spinners and in order to make delivery it was necessary to get the cotton to New York within seventeen hours. One of the railroad traffic officials in speaking of this run said that it was significant in showing that the Canadian rail and ocean service was wholly inadequate in cases of emergency when certainty of delivery is important. From this it was maintained that the trunk lines are in absolutely no danger of losing their prestige to the Grand Trunk or the Canadian Pacific.—*New York Herald.*

THE MACHINIST MUST BE A SPECIALIST.

The writer was in a railroad repair shop recently when the division superintendent brought in a typewriter to be fixed—said it was out of kilter. The foreman looked at it, struck a key or two, and remarked: "I don't know much about these things." "Why," exclaimed the superintendent, "you have the reputation of being the best mechanic on the road; I thought you were just the man." The foreman turned to the speaker and said: "I am a locomotive repair machinist, and have carefully studied it for fifteen years; if you will bring me any job on a locomotive that I cannot do that any other mechanic can, I will resign, but life is too short for a man to spread himself out so thin as to attempt to be familiar with all classes of machinery. There are men who make a specialty of typewriters, as I do of locomotives. They can repair that machine in half the time, for half the money, and twice as well as I can. I would be as foolish to attempt to put new letters on that machine as the maker of typewriters would be to put a new tire on a locomotive."—*Railway and Locomotive Engineering.*

THE BAND SAW IS AN ENGLISH INVENTION.

The well-known English author of several books on wood-working machinery, Mr. M. Powis Bale, of London, takes issue with the *Timber Trades Journal* of the same city regarding the invention of the band saw, which was attributed by that publication to a Frenchman. He says:

"I notice that the invention of the band saw is attributed to M. Perin, of Paris. This is an error, as it was really the invention of an Englishman—one William Newberry, who, in 1808, patented a machine for sawing wood, in which an endless band or ribbon saw strung over two wheels was used. Owing to the difficulty, however, of obtaining saw blades that would withstand the strain put on them, the machine remained in abeyance for many years, till M. Perin, about 1855, introduced a much improved machine on which he used specially-tempered saw blades of French manufacture, and thus made the machine a practical commercial success. The early history of wood-working machinery is extremely interesting, and I would draw your attention to the marvelous patent specifications of Sir Samuel Bentham in 1791 and 1793, as they are truly remarkable examples of inventive genius, and fully illustrate the old adage, 'There is nothing new under the sun.' In these specifications the principles involved in many of the most important wood-working machines at present in use are claimed and set forth in the clearest and tersest manner, including planing machines with rotary cutters to cut on several sides of the wood at once,

veneer cutting machine, horizontal saws, molding and recessing machine, bevel sawing machine, saw sharpening machine, tenon cutting by means of saws, and many kinds of rotary and boring tools. Well may the disappointed inventor say, 'Those beastly ancients have cribbed all our best ideas.'"

ELASTICITY OF CAST IRON PISTON RINGS.

A somewhat elaborate paper on cast iron for piston rings was read by Mr. C. H. Wingfield before the British Association, September 16, in which he referred to what we infer is a generally well-known fact, and that is, that cast iron is not initially elastic, but becomes so only after it has received a permanent set. That is, any ordinary piece of cast iron when placed under a bending stress for the first time, does not return to its original shape when the load is removed, but suffers a permanent change of form. After the permanent set has been given it, however, cast iron is perfectly elastic within limits. Mr. Wingfield made experiments on piston packing of the class having an inner and outer ring, the outer being turned to same diameter as the cylinder bore and the inner ring turned to a larger diameter than the bore of the outer ring. These inner rings were made 5.236 to 5.728 inches diameter, and had sections cut out so that they could be pushed into a ring gage 5.039 inches diameter, to determine the amount of permanent set and the "follow" (reduction in diameter) of the ring. He was surprised to find that a ring 5.236 inches diameter having a section 1½ inches cut out, could be bent until the ends met without fracture and that they would spring back to within ⅜ inch of their original position an indefinite number of times without taking any further permanent set. He found that some time was required of the rings pushed within the ring gage before the maximum permanent set was acquired. For example, the follow in the case of a ring 5.433 inches diameter was .396 inch before being pressed into the ring; after being in the ring one minute, it was .291 inch; after fifteen minutes, .287; after forty minutes, .280 inch; and after forty-eight hours, .275 inch.

In this connection it may be mentioned as a matter of interest and possibly of news to some, that cast-iron packing rings often show a wonderful increase of flexibility (not elasticity) with use. The editor has repeatedly tested certain old cast-iron packing rings used in locomotive cylinders, say 20 inches diameter, by placing a foot on one end and pulling the other end of the ring upward in a direction parallel to its axis, to the level of his shoulder—he is not a short man—before it fractured. In such cases the observers would almost invariably declare that the ring must be made of wrought iron so great was its flexibility, but such was not the case in any instance, as was easily discerned from appearance of the fractures.

MOUSE POWER.

In these days of 12,000-horse power stationary steam engines, 100,000-horse power central stations, and 1,000,000-horse power Niagara development (near prospective), it is somewhat difficult to appreciate the scarcity less than one hundred years ago and the shifts made to gain that which more than anything else has made present civilization possible—power. The following remarkable item published by the *Scotsmen* and copied by the *Tradesman*, to whom we are indebted, may be an exaggeration, but it undoubtedly records one of the schemes seriously contemplated for operating machinery:

"About the year 1820 this gentleman actually erected a small mill at Dunfermline for the manufacture of thread—a mill worked entirely by mice. It was while visiting Perth prison in 1812 that Mr. Hatton first conceived this remarkable idea of utilizing mice power. In an old pamphlet of the time, 'The Curiosity Coffee Room,' he gave an account of the way in which the idea dawned on him. 'In the summer of the year 1812,' he wrote, 'I had occasion to be in Perth, and, when inspecting the toys and trinkets that were manufactured by the French prisoners in the depot there, my attention was involuntarily attracted by a little toy house with a wheel in the gable of it that was running rapidly round, impelled by the insignificant gravity of a common house mouse. For a shilling, I purchased house, mouse and wheel. Inclosing it in a handkerchief, on my journey homeward I was compelled to contemplate its favorite amusement. But how to apply half-ounce power, which is the weight of a mouse, to a useful purpose was a difficulty. At length the manufacturing of sewing thread seemed the most practicable.' Mr. Hatton had one mouse that ran the amazing distance of eighteen miles a day, but he proved than an ordinary mouse could run ten and one-half miles on an average. A half-penny's worth of oatmeal was sufficient for its support for thirty-five days, during which it ran 736 miles. He had actually two mice constantly employed in the making of sewing thread for more than a year. The mouse thread mill was so constructed that the common house mouse was enabled to make atonement to society for past offenses by twisting, twining and reeling from 100 to 120 threads a day, Sundays not excepted. To perform this task, the little pedestrian had to run ten and one-half miles, and this journey it performed with ease every day. A half-penny's worth of oatmeal served one of these thread mill culprits for the long period of five weeks. In that time it made 3,350 threads of twenty-five inches, and as a penny was paid to women for every hank made in the ordinary way, the mouse, at that rate, earned 5 pence a day, or 7 shillings and 6 pence a year. Taking 6 pence off for board and allowing 1 shilling for machinery, there was a clear yearly profit from each mouse of 6 shillings. Mr. Hatton firmly intended to apply for the loan of the old empty cathedral in Dunfermline, which would have held, he calculated, 10,000 mouse mills, sufficient room being left for keepers and some hundreds of spectators. Death, however, overtook the inventor before his marvelous project could be carried out."

EXPERIMENTS TO DETERMINE THE AIR FRICTION OF DISKS.

Abstract of Paper read by William Odell before the British Association at Southport, September, 1903. Electrical Review (London), September 25, 1903, p. 490.

The experiments were made with the object of finding a convenient method of determining the power wasted by air friction or windage of flywheels, armatures, etc. They were made with paper disks mounted on the shaft of an electric motor. The excitation being kept constant, the torque was proportional to the current. Thus the extra current required to keep up the speed after the disk was fixed on the shaft, gave the power absorbed by air friction.

There was found to be an angular speed for each disk above which the torque was accurately proportional to about 2.5 power of the speed. This critical speed appeared to vary inversely as the square of the diameter. Below it the law followed was of a lower degree; but owing to the multiplication of errors of measurement no definite conclusion as to its exact nature was arrived at.

As the three disks originally tried gave uncertain results as to the effects of size, a much larger one, nearly 4 feet in diameter, was also tried; and as a result of all the experiments it was concluded that the torque varies as about the 5.5 power of the diameter.

To give an idea of the amount of power thus absorbed, it may be stated that a disk of 47 inches required 1-10 horse power to keep up a constant speed of 500 revolutions per minute, and that if the above law holds, a 9-foot disk would absorb 10 horse power at the same speed.

STANDARDIZING MACHINE TOOL PARTS.

Extract from Paper read by Mr. William Lodge before the New York Meeting of the National Machine Tool Builders' Association, November 10, 1903.

It would be to the interest of this association, if it could possibly be brought about, that some standard be adopted. Why may not all manufacturers of machine tools have the same size of general bearings, the same size of nose for the lathe spindles for the different sizes of lathes, so that our customers may find it easy to transfer faceplates, chucks, and tools from one machine to another, irrespective of who may have been the manufacturer. If this matter can be brought about we shall be the first country to have adopted a uniformity. This would be a most important matter, not only to ourselves but to the men to whom we sell, and it would, at least, have the effect in foreign countries of securing preference for American tools, because of their interchangeability at certain points and because of their uniformity in weight and power. I do not advocate uniformity in the design of the machines throughout, and I know it is utterly impossible to secure uniformity in the quality of the work put into the machines but it will be of great assistance to incorporate the features mentioned wherever possible. If the salesmen for the different

houses were attempting to get trade in either Europe, Asia or Africa, and the statement could be made that chucks and tools could be interchanged from one machine to another, no matter who the maker was, it would be bound to result in a preference for American goods. As we are all likely to have to make new designs, it would be well if it were possible to bring about this interchangeability. Would it not also be well to establish uniform widths and diameters for countershaft pulleys and for the countershaft itself, because these vary so much as to appear ridiculous at times?

APPLICATION OF AIR BRAKES TO THE TRUCKS OF LOCOMOTIVES ON THE STATE RAILWAY OF BELGIUM.

Bulletin of the Railway Congress, June, 1903, p. 589.

The management of the State railways of Belgium have realized the advantages to be obtained by the application of brake-shoes to the wheels of bogie trucks on locomotives. Heretofore, shoes operated by the Westinghouse brake have only been applied to the driving wheels of locomotives. An arrangement designed by the motive power department has just been tested on a four-coupled engine. Several months of service have shown that this supplementary braking on the locomotives makes it possible to secure a very material reduction in the distances needed in which to stop trains. Further tests are in progress in order to determine the time advantage that can thus be obtained at different speeds upon the several lines of the State railways. G. L. F.

SUPERHEATED STEAM FOR STEAM ENGINES.

Cassier's Magazine, November, 1903, p. 18.

The weight of steam used per indicated horse power is materially less when the steam is superheated than when saturated steam of the same pressure is used. If the consumption be taken as 100 for saturated steam, it will be roughly as given in the following table, when superheated. In other words, each 50 deg. of superheat in a reciprocating engine reduces the former consumption by about 10 per cent., and by 5 per cent. in the case of a turbine, which is in inverse proportion to the volume of the steam or to the absolute temperature. This must be taken only as a rough approximation, but it nevertheless, agrees tolerably well with the results of experiment.

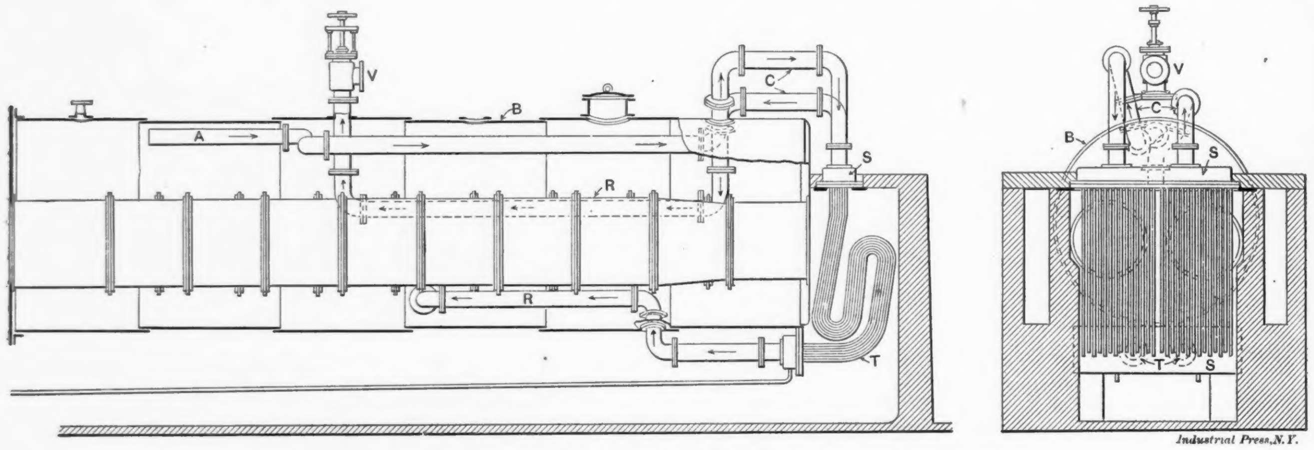
Superheat at the Engine.	Consumption. Turbine.	Reciprocating Engine.
...	100	100
50° F.	95	90
100° F.	90	81
150° F.	86	73
200° F.	81	66
250° F.	77	60
300° F.	73	53
350° F.	69	48
400° F.	66	44

This economy is largely due to the fact that the temperature of superheated steam is considerably above its saturation or condensing point; consequently when it enters a cylinder cooler than itself and its temperature is thereby reduced, the usual cylinder condensation does not take place until the temperature is reduced to that of saturation. Cylinder condensation is, therefore, largely reduced, and if the superheat be sufficiently great, the condensation may be entirely overcome.

The decreased steam consumption is due also to the fact that the volume of the steam is increased by the superheating in amount almost proportional to the absolute temperatures before and after superheating. Since its capacity for doing work at any given pressure varies almost directly as its volume, it follows that a given weight of steam has a greater capacity for doing work when occupying a greater volume than before; consequently a smaller weight of steam is required to do a given amount of work. A minor advantage, apart from the question of economy, is that the steam supplied to the engine is perfectly dry when it is superheated, and the dangers of priming are thus avoided. Now that so many water-tube boilers are used which nearly always prime badly when forced, the question of getting dry steam, especially with high speed engines, is becoming one of very great importance.

The disadvantages of highly superheated steam are that the steam not only supplies no water of condensation to lubricate the rubbing surfaces of the valves and cylinders, but it decomposes many of the oils that are fed into the cylinder for lubricating purposes; hence the valve faces, cylinders, and pistons are liable to become badly scored; also, the gland packing not infrequently is burnt or melted out.

It must, however, be remembered that these are troubles which arise only when high degrees of superheat are adopted. Thus, in order to get some of the benefit to be derived from superheating without experiencing the troubles mentioned above, it is necessary, under ordinary circumstances for power purposes, to use only very moderate degrees of superheat, say 100 degs. F. This, however, is a difficult matter to accomplish, unless a special regulator or modifier be used to keep the superheat within any given limits. With many of the superheaters in common use, it will vary a hundred degrees or more in a very few minutes unless it be very carefully watched.



Elevation and End View of a Boiler Fitted with McPhail & Simpsons Superheater.

When considering the disadvantages of superheating, the fact must not be overlooked that in a great many cases the superheater tubes have been known to burn out. The burning away of the superheater tubes has occurred in most cases where flooding arrangements have been used, as a deal of scum and scale is carried into the tubes with the water, and if the flooding is frequently indulged in, the tubes, in time, get choked up, with the inevitable result that they burn out, thereby making the wear and tear an important item, as compared with the reduced coal bill. Again, it must not be forgotten that superheaters which are not furnished with a device for regulating the temperature become a source of trouble and expense if neglected.

The McPhail & Simpsons superheater, says the writer, Mr. John Goodman, has been designed with the express purpose of overcoming most of the disadvantages enumerated above, primarily by producing superheated steam at a controlled and constant temperature, and, further, by utilizing more of the heat of the escaping gases than can be accomplished by ordinary economizers and feed heaters.

The apparatus in one style consists of superheater tubes *T*

connected together by top and bottom boxes *S*, which are divided into two compartments; connections to and from the superheater *C*; radiating pipes in the water space of the boiler *R*; and anti-priming pipe *A*. The steam passes from the anti-priming pipe *A* to the connecting pipes *C*, and thence through the first compartment of the top box and through the first nest of superheater tubes to the first compartment of the bottom box and into the radiating pipes *R*, which are placed in the water space of the boiler below the fire flues. It then passes out of the boiler again into the second compartment of the bottom box and up through the second nest of superheater tubes to the second compartment of the top box, and, by connections *C*, into the radiating pipes *R*, placed in the water space above the fire flues, and leaving the boiler at the stop valve. It will be observed that the steam is superheated twice and carried into the boiler twice, where it gives up a part of its surcharged heat each time to the water in the boiler, thereby assisting evaporation, the steam leaving the stop valve at a controlled and constant temperature. This apparatus is constructed of steel throughout. The superheater tubes are of cold, solid-drawn steel. The tube-plate is of rolled mild steel, 1¾ inches thick, and the boxes are of rolled mild steel plate, dished.

MONEY VALUE OF TRAINING.

Abstract of Paper read by Mr. James M. Dodge before the Williamson Trade School of Philadelphia, March 1903. From St. Nicholas Magazine.

When the trade guilds were in active existence in England and this country up to 1850 they gave thorough instruction to apprentices in the various crafts. A shoemaker's apprentice, besides learning how to make boots and shoes, might also learn to tan skins, make thread and wax, carve his lasts, build his own furniture, and, in fact, produce from the raw material everything required for the prosecution of his calling. But with the decline of the guilds, due to the introduction of labor-saving machinery, the opportunities for learning a trade dwindled away. Generally speaking, there are now few opportunities for a young man to acquire the trade of a machinist in the shops of this country. In the first place the establishments are frequently so large that an individual is entirely lost sight of. If he does the special line of work assigned him, he is allowed to remain in one place indefinitely. Frequently the training of years in one shop will not enable a man to get employment at good wages in another. The trade unions have not filled the place of the guilds in this respect; they pay no attention to the training of apprentices or otherwise recognize them, beyond limiting so far as possible the number that shall be employed. The attitude of the trade unions to apprentices is purely "negative."

In years gone by the apprentice was trained in a large range of duty incident to the work of a machinist, in a broad sense; but there is no longer in the machinist trade true apprenticeship. We believe that a month in a good trade school is worth a year in a large shop, so far as the matter of training in first principles is concerned. Of trade schools locally we have some splendid examples—the Drexel Institute, the Williamson Trade School, the manual training school, and others. But scattered over the country are schools of this character which undoubtedly will grow more rapidly than any educational institutions of the past.

It has been said that a three years' course in a trade school, in which an average of but a few hours a day is devoted to actual manual work, can in no way compare with three years' time spent in actual work in a shop. This is felt to be a popular error. In shop work a man may spend months in repetition of the same task, to no ultimate advantage to the worker. Instead of his skill being quickened it is dulled. He very quickly acquires the skill which is unconscious in its operation, and, like the old lady with her knitting needle, he can talk to a fellow-workman or think and dream about far distant places and matter without in any way lessening the rate of production. In fact, sometimes his pace might be actually quickened by some mental emotion having an exciting effect upon his nervous organization, in the same way that the old lady, in chatting with her friends, will knit fast or slow in harmony with the dullness or animation of the conversation. It is quite obvious that repetitive routine work is not desirable for a young man of natural ambition and aptitude. In the trade school he escapes routine, but is instructed in the underlying principles of his work, and does enough manual labor to familiarize himself with the various tools required and tend to prove the correctness of the theories in which he has been instructed.

The trade school training is one decidedly tending toward individualism. Its boys, as a rule, do not come from the wealthier classes. There is earnestness of purpose, and the records show that the percentage of failure to pass satisfactorily through the course is exceedingly small. In opposition to this, it not infrequently happens in our larger universities of learning that less than one-half of those entering the freshman classes graduate. Not more than 5 per cent. of the boys entering the trade schools fail to complete the course satisfactorily, and the tasks set are no less exacting than those in our large colleges and universities. This may be attributed to the fact that no boy enters a trade school without a positive determination to complete the course and be thankful for the opportunity. None are forced to go through the ambition of their parents, because, as a rule, the decision to send a boy to one of the trade schools is a serious sacrifice on the part of his family. In the trade school the boy is impressed with the idea that his first day there is the beginning of his career. In our larger institutions the day after commencement is looked upon as the beginning of the career. This is a very important distinction. Again, in entering the trade school a boy has already made up his mind what his life work is to be. In the majority of cases, boys entering

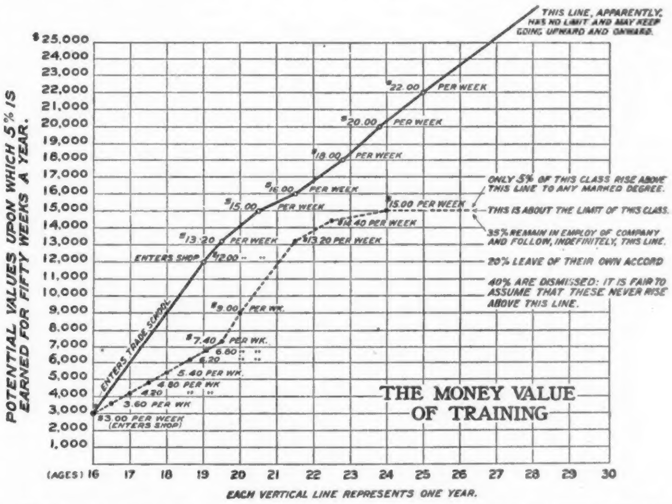


Diagram giving Curves showing the Comparative Value of Trade-school and Shop-trained Boys. Curves Plotted from Records of two Groups of twenty-four Boys each.

our universities have no clearly defined idea of their future work after graduation. As a result, the trade school boy can directly apply the training he has received toward increasing his value to his employer and himself.

Now for a comparison of values of the trade school boy and the shop trained boy. The boy of sixteen who is tired of going to the day school thinks he will learn a trade. His father does not oppose his leaving school perhaps because he thinks, from his own experience, that the boy has enough "schooling." The boy naturally selects some trade because he sees all about him the relatively affluent position of the men working at trades and those who are simply laborers. Say he obtains employment in a machine shop where he will receive about $3 per week, this being, we will say, $150 per year, or 5 per cent. on $3,000. The dotted curve in the diagram shows his probable money value up to 26 years, beyond which age only about 5 per cent. increase their earning capacity. The full line shows the probable earning capacity of the trade school boy, and its upward tendency apparently has no limit. This diagram was plotted from two groups of twenty-four boys each, or forty-eight in all, one-half entering the trade school and the others going directly into the shop.

The untrained boy in three years has increased his earning power from $3 per week to $6.80, and the Williamson School boy in traversing the line between his entrance and graduation crosses the $6.80 line after he has been in the school a

year and three months. In other words, he has gained almost two years on the boy who entered the shop with the idea that school training was an unnecessary waste of time. It is quite evident, therefore, that time has been lost, and not gained, by entering the shop without training. Roughly, this holds true indefinitely. While the two lines run along parallel or substantially so, say for the next four or five years, the time element is always in favor of the trained boy, and that in a very few years he is leaving his less fortunate brother well to the rear.

From the age of 20 to 21½, or for 18 months, if the untrained boy continues to do his work well, it will be seen, by reference to the chart, that his line has continued running more toward the vertical than it did from the time he was 16 until he was 19½. Now the experience which he received during the formative period is beginning to make itself very manifest. He becomes more useful as an all-around man, and his rate is increased to $13.20 per week. Carried back to the left, we find that his potential value is working upward toward $14,000. A year later, or taking the age 22½, his wage has been increased to $14.40 per week. Again we see his potential value has gone up beyond $14,000. For the next 18 months he continues in substantially the same line, and at 24 years of age is earning $15 per week, and his potential value is $15,000. In other words, he has increased his potential value $12,000, and draws the interest on his investment in instalments once a week, and is earning 5 per cent. on his accumulated value.

We find that only 5 per cent. of this class rise above this line to any marked degree. Thirty-five per cent. remain in the employ of the company and follow the line indefinitely. Twenty per cent. leave of their own accord, but with good records behind them (so that probably the same statistics would apply to them also—that is, 5 per cent. of them may rise above the line and 35 per cent. of them follow the line in other establishments). Forty per cent. are dismissed, and it is fair to assume that these never rise above the line. They are not dismissed at the age of 26, but fall by the wayside, unable to keep pace with the march of progress.

We will now turn to the group who have entered the trade school. Starting again at the potential value of $3,000 for the boys of 16 years of age, we will follow the course of an individual, representing the average of his companions. The first noticeable thing is that for three years, starting from the age of 16 and terminating on the line representing 19 years, he is in school; and instead of having his wage-rate dotted along at intervals of 6 months, as in the case of the boy entering a shop without the trade school training, we find no rates at all, and we feel justified in making this line perfectly straight, with the first money entry made upon it at the time of his graduation, at the age of 19, and entering upon his employment. We now find a most interesting state of affairs. He is employed at the rate of $12 per week, this representing a potential value of $12,000, or an increase *during his school term* of $9,000, or an average of $3,000 per annum. During the same term the untrained boy has reached a potential of $7,000 at the same age; in other words, the trained boy has a $5,000 start at the same age. Again, the untrained boy's line crosses the $12,000 potential line at a point which indicates that he is 21 years of age. In other words, the trained boy has $5,000 advantage at the same age, and has two years running start on the boy who has not had the same training. Now, what does he do in the next two years? To follow along his career, it will be noted that in six months his rate has been increased to $13.20 per week. One year later, or at the age of 20½, he has reached $15 per week. The untrained man is now 24 years old and earning the same wage, but his line of progress is running more nearly parallel with the horizontal line than that of the trained man. Six months later, at the age of 21½, they part company quite decidedly, the untrained man's line running off horizontally to the right, whereas the line of the trained man is progressing onward and upward, at substantially the same angle it has shown since the time of his entrance to the trade school. Why is it possible for these two men thus to part company? It is because the untrained man can increase his rate only by remaining as a working machinist in a shop. The trained man has substantially mastered all that the untrained man has, so far as his actual labor is concerned, but he has within him other possibilities. He can now apply in a combined manner his theoretical and his practical training, becoming a leading man, possibly a foreman or a draftsman. It is now that this, his better knowledge, coupled with his intellectual improvement, makes itself most manifest. His rate at the age of 21½ is $16 per week; his potential value $16,000. Fourteen months later we find him earning $18 per week; ten months later $20 per week; and in another year, or at the age of 25, he is earning $22 per week—a rate practically unattainable by the untrained man. Five per cent. of the untrained—those having decided genius and a faculty of improving their minds and increasing their theoretical knowledge, courage enough to take courses in the correspondence schools or obtain instruction in the evenings—rise to his class, and it is not impossible that in very rare instances would do as well through their future life. A trained man at 25 years of age has a potential value of $22,000, or in nine years he has increased his value $19,000, or at the rate of $2,100 per annum, as compared with $1,300 per annum for the untrained man, and with this manifest additional advantage over the untrained man—that his line has no limitation, so far as we can see.

THEORETICAL EFFICIENCY OF WORM GEARING AND TESTS OF SAME.

Page's Magazine, November, 1903, p. 428.

Worm gearing differs from most other forms—belting, spur gearing, etc., in that it requires very accurate design and manufacture to be efficient. It has always been more or less under a cloud on account of bad examples of the gear which have been set to work. Several firms, however, amongst whom may be mentioned the Oerlikon Company have consistently stood by the gear, and by turning out good work have helped materially to win for it the position it now holds as one of the best mediums for electric motor driving. One of the distinct advantages of the gear is its *noiselessness*, and this undoubtedly has a money value. As there still exists a certain amount of mistrust as to the efficiency, it may be of interest to give some figures obtained by the Oerlikon Company.

TABLE GIVING THEORETICAL EFFICIENCY OF WORM GEARING.

Coefficient of Friction.	Angle of Inclination.								
	5 deg.	10 deg.	15 deg	20 deg.	25 deg.	30 deg.	35 deg.	40 deg	45 deg
0.01	89.7	94.5	96.1	97.0	97.4	97.7	97.9	98.0	98.0
0.02	81.3	89.5	92.6	94.1	95.0	95.5	95.9	96.0	96.1
0.03	74.3	85.0	89.2	91.4	92.7	93.4	93.9	94.1	94.2
0.04	68.4	80.9	86.1	88.8	90.4	91.4	92.0	92.2	92 3
0.05	63.4	77.2	83 1	86.3	88.2	89.4	90.1	90.4	90.5
0.06	59.0	73.8	80.4	84.0	86.1	87.5	88.2	88.6	88.7
0.07	55.2	70 7	77 8	81.7	84.1	85.6	86.4	86.9	86 9
0.08	51.9	67.8	75.4	79 6	82.2	83.8	84.7	85.2	85.2
0.09	48.9	65.2	73.1	77.6	80.3	82.0	83.0	83.5	83.5
0.10	46 3	62.7	70.9	75.6	78.5	80.3	81.4	81.9	81.8

The efficiency increases with the angle of inclination up to a certain point, and with the smallness of the coefficient of friction, and knowing these two factors it is possible to calculate the theoretical efficiency as shown in the table. Experience shows that for larger angles of inclination than 25 degrees to 30 degrees the efficiency increases very little, especially if the coefficient of friction is small, and this fact is of importance in practice, because, for reasons of gear ratio and conditions of a constructive nature an angle greater than 30 degrees cannot be employed. The coefficient of friction increases with the load and diminishes to a certain extent with increase of speed. Besides the friction between the worm and the wheel teeth there is also the friction of the spindle bearings and the ball bearings for taking the axial thrust. To obtain the best results, there must be very careful choice of dimensions of teeth, of the stress between them, and the angle of inclination. Also the most accurate workmanship in which the hardening of the worms without any consequent

retouching, forms an important part. To show what can be done, the following are the results of a test with an Oerlikon worm gear for a colliery winding engine: The motor gave 30 brake horse power to 40 brake horse power at 780 revolutions. The normal load was 25 brake horse power, but at starting it can develop 40 brake horse power. The worm gear ratio is 13.6 to 1, the helicoidal bronze wheel having 68 teeth on a pitch circle of 7.283 inches and the worm 5 threads. The power required at no load for the whole of the gear was 520 watts, corresponding to 2.8 per cent. of the normal. The efficiency at one-third normal load gave 90 per cent., at full load 94½, and at 50 per cent. overload 93 per cent. The efficiency of the *worm and wheel alone* is higher, and knowing the no load power, it calculates out at 97½ per cent. According to the above table of theoretical efficiencies this gives the coefficient of friction as 0.01. To obtain a reduction of 13.6 to 1 with spur gear would have necessitated two pinions and two wheels with their spindles and bearings, and if the bearing friction was taken into consideration the efficiency of such gearing would certainly not have reached the above-mentioned figure of 94½ per cent. at full load.

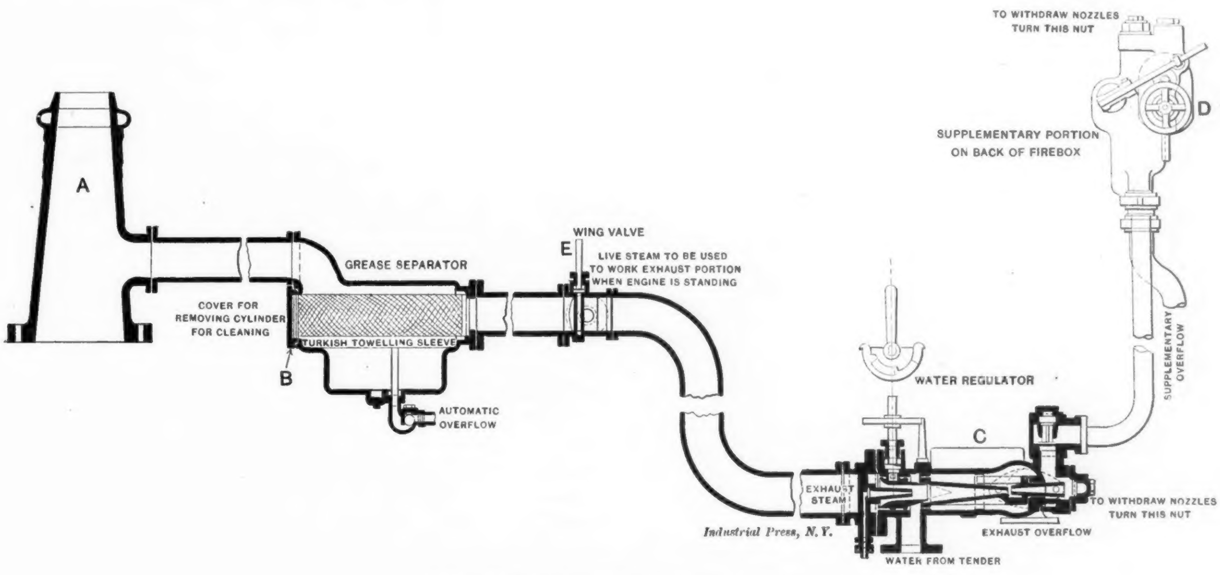
LOCOMOTIVE INJECTOR OPERATED BY EXHAUST STEAM

Fielden's Magazine, November, 1903, p. 422.

In locomotive feed-water injection it is highly desirable that the temperature of delivery be the highest degree attainable at which the injector will work without breaking. If this heat can be abstracted from the exhaust without increasing the back pressure it is apparent that an economy will result. While the ordinary type of high-pressure steam injector will not work satisfactorily when the supply water in the tender is even moderately warm, the exhaust steam injector made by Davies & Metcalfe, Manchester, it is claimed, in connection with the supplementary apparatus, will deliver water to the boiler at a temperature of 270 degrees F. Thus, while it is not feasible to utilize the heat of the exhaust to warm the supply water with the ordinary injector to any extent, it is possible with the exhaust steam injector to use a considerable portion of it and to deliver the water in a large volume at so high a temperature that it cannot have a bad effect upon the plates or tubes.

The exhaust pipe, *A*, is tapped near its base for the steam supply. A grease extractor, *B*, is provided to remove the oil and water of condensation. From thence the steam passes into the exhaust injector, *C*, which, of course, is of the non-lifting type, being located beneath the foot-plate. But because of its weak forcing power it is necessary to provide the supplementary injector, *D*, to take the water from the exhaust injector—which it does at a temperature of 200 degrees and a pressure of about 70 pounds—and deliver it to the boiler, which it does at a temperature of 270 degrees as stated. A wing valve, *E*, is provided in the exhaust pipe between the oil separator and the first injector which may be closed, and a live steam valve opened to work the injector when the locomotive is standing idle.

It is stated that the firm making these injectors have applied a large number of them to locomotives on various English railways, and that they are working successfully.



British Locomotive Exhaust Steam Injector.

ELECTRICITY IN MANUFACTURING PLANTS.

Abstract of Paper by Walter M. McFarland before the Society of Naval Architects and Marine Engineers.

In considering the relative merits of alternating and direct-current for motor driving, it is the writer's opinion that if the induction motor had been the first to enter the field there probably would have been no room for argument, because its merits are so great that there would have been little incentive to develop anything else. It happened, however, that although alternating current was the first, as it is the natural product of any machine without special commutating devices, it was some time before a commercially practicable alternating current motor appeared, and the direct current motor, being first in the field and being undoubtedly meritorious, acquired the vogue which always comes to that with which people are familiar.

Mechanically the induction motor appeals at once to every practical man as the better device. The coils of wire are entirely stationary, while the rotating part consists of disks of sheet steel enclosed by massive composition end rings, which latter are connected by stout bars of copper bedded in slots in the steel sheets. The direct current motor, on the contrary, has its coils movable as well as stationary, and, while these do not often give trouble, they are not so simple and mechanical as the rotating part of an induction motor. The direct current motor has an additional feature which is entirely absent in the alternating current motor—the commutator and brush holder. These are the parts requiring most attention and the ones most liable to give trouble, although the modern methods of design and manufacture have reduced this to a minimum. The efficiency of the induction motor is fully equal to that of the direct current motor and indeed is slightly better over most of its range of capacity.

Thus far it might seem that everything is so greatly in favor of the induction motor that there could be no room for choice; but this type has one defect, namely, it is a constant speed motor, and many of the foremost advocates of individual tool driving want a motor whose speed can be varied through a wide range. While it is entirely possible to make an induction motor whose speed can be varied, the extreme simplicity of the first type is lost on account of the slip rings, which are used to enable the variable speed to be obtained by throwing resistance into the circuit. These, while not so liable to derangement as the commutator of a direct current machine, do add a slight additional complica-

tion. Before going on to explain some of the different methods by which variable speed is obtained with direct current motors, it may be mentioned that in the New York Shipbuilding Company and also in the steam engineering plant at the Brooklyn Navy Yard, the simplest type of induction motor is used, and the variable speed is obtained by means of belts and cone pulleys. In the opinion of the writer this method is entirely satisfactory and gives an adequate range of speeds with extreme simplicity.

It may be well to mention, in speaking of direct current motors, that apart from crane service, the type of motor almost universally used in industrial plants is the shunt motor, so called because the field circuit is a shunt from that of the armature. The shunt motor is inherently self-regulating, and within moderate limits the speed remains constant without regard to the load coming upon it. One of the simplest methods of varying the speed is by varying the field strength, which can be done by introducing a suitable rheostat in the field circuit, and as only a small portion of the current goes through this circuit anyhow, the loss is immaterial. The speed can also be varied by introducing resistance in the armature circuit to cut down the E. M. F. acting upon the armature, but this is objectionable on account of the large amount of energy wasted as heat in the resistance.

Another method which has been used with decided success and simplicity is the three-wire system from a single generator in connection with field regulation, which enables the speed of the motor to be varied sufficiently to meet all practical purposes. The three-wire system is obtained by utilizing a special generator somewhat resembling a rotary converter; that is, in addition to the brushes and commutator furnishing direct current, leads are brought out from the armature winding to two or more slip rings placed upon the armature shaft. From these slip rings alternating current is taken, and if this is passed through an auto-transformer, and a lead is tapped from the middle of the transformer coil, this lead will always have a potential midway between that of the terminals on the direct side of the machine, thus securing at the motor two voltages, one equal to twice the other. By field regulation the speed can be varied through a ratio of about one to three, so that with this variation combined with the two voltages of the three-wire system we get a range of six speeds, which, in general, will be amply sufficient.

Another system, known as the multi-voltage system, has also been used to some extent with direct current motors, consisting of a number of circuits working at different voltages. Suppose that, commencing with a negative wire, the voltage rises to 60 at the second wire, 140 at the third, and 250 at the fourth, thus giving intervals of 60, 80 and 110 volts. It is obvious that we can get any of the three voltages by the intervals, and by varying the wires we can get in all six voltages. If the field of the motor is constantly excited at, say, 250 volts, the several voltages applied to the armature will give as many different speeds, and the gaps between may be filled in by slightly varying the field excitation. The objection to this system is the complication of the generating apparatus and of the wiring.

Still another system is that called after the name of its inventor, the Ward-Leonard system, which depends upon supplying a current of varying voltage to the motor by varying the field strength of the generator, the field of the motor being constantly excited from an independent constant potential circuit. This is the system employed for turret turning on board naval vessels, where it has worked very successfully, and it was described in detail some years ago in a paper before the Society, so that we need not go into it further here. It will be seen that the objection to this system is its enormous complication when attempting to apply it to so large a number of motors as would be found in a manufacturing establishment.

An advantage of the induction motor is that from its construction there is no danger from a short circuit, because the bars in the rotating part are purposely short-circuited. Further, this motor will stand being brought to a full stop for a moment with the full current upon it without any resulting damage, while such an occurrence with a direct current motor would certainly burn out the insulation, if not doing still greater damage. As a result of this it is not necessary to fit circuit breakers or fuses to take care of these motors. In the small sizes the motor can be started up by simply closing the circuit by means of an ordinary switch, and in the larger sizes practically the same thing is done, as a two-throw switch is used in connection with an auto-starter, which is simply a small transformer arranged to give half the line voltage in starting up. The object is not so much the protection of the motor itself as to avoid the demand for a large amount of current from the generating system, as the starting current without the transformer would be somewhat more than twice full-load current. In the case of the direct current motor it is, of course, necessary to start through the rheostat, so that the full voltage only comes on when the motor is up to speed.

In regard to individual and group driving some engineers go so far as to say that they would have a motor for each tool, even if it involved going to sizes as small as one-quarter horse power, but the writer is inclined to believe that the judgment of more conservative engineers is favorable to individual driving where the power required will be, say, from five to ten horse power and upwards, and for group driving where the individual tools would require less than those amounts. In any large plant there are numerous small tools, such as drill presses, screw-cutting machines, light lathes, etc., which are in any case located together, and where it is perfectly easy to drive them as a group. The average power required for such a group will be quite uniform, and when they are group driven a moderate sized motor, with its relatively high efficiency, can be used with a fairly steady load, thus contributing to the efficiency of the general system, as well as of the particular group, and materially reducing the first cost of the installation.

ACETONE AS AN ABSORBENT OF ACETYLENE GAS UNDER PRESSURE.

Extract from Paper read by Mr. E. G. Fisher before the International Acetylene Association at Chicago.

In 1896 Messrs. Claude and Hess, two French engineers, conceived the idea of utilizing some liquid as a solvent of acetylene, and after many experiments discovered that acetone (a limpid, mobile liquid, with an agreeable odor and burning taste, produced by the destructive distillation of acetates, and procured on a large scale from the aqueous liquid obtained in the dry distillation of wood) has the property of absorbing many times its volume of acetylene gas. This property varies greatly with the pressure and temperature under which the acetylene is applied; the acetone will again release the gas absorbed under pressure, when the pressure is removed. Acetylene dissolved in acetone is inexplosive, as has been shown by Messrs. Berthelot and Vielle, French chemists. It is an inert liquid, so that if an explosion be intentionally produced in the compressed gas outside or above the solution, the solution would not be affected thereby. Thus, if a red-hot wire were inserted into a tank containing acetylene dissolved in acetone, under a pressure of 240 pounds per square inch, the small quantity of gas that exists above the liquid would explode, but the liquid would not be influenced in the least. This was a long stride in the direction of safely transporting acetylene, but absolute safety is demanded in a gas-lighting system, especially for transportation, and it was Edward Fouche, another Frenchman, who conceived the idea of packing the gas cylinders with an absorbent or porous material, thereby filling the entire air space—except, of course, the small cells in the porous brick or asbestos—then introducing sufficient acetone into the tank to moisten the cell walls of the porous brick or asbestos. This has been proved to make an absolutely safe structure for storing and transporting acetylene in small or large quantities.

Acetylene gas absorbed in acetone is now being safely and efficiently used for railway car lighting, having decided advantages over the Pintsch gas system both in efficiency and in manufacture. The ability to transport acetylene safely while under heavy pressure gives the world the use of an illuminant unequaled in brilliancy by any save the electric arc lamp.

ADJUSTABLE DIE HEAD AND METHOD FOR MAKING THREADERS FOR USE IN SAME.

JOSEPH M. STABEL.

Economical thread cutting and the production of the tools for accomplishing the same, form a very important item in many factories, especially where several hundred sizes of threads are used, so that to make a solid tap for each size would be very expensive. The tools and method here described, while by no means inexpensive in the first cost, will, when once brought into use on such work, produce a great saving over the cost of making solid tools for each size of thread, and the cutting tools, or threaders, when worn out may be renewed at a very small expense. Another advantage of this method is that found in the fact that many shops use quite an assortment of different styles of threads, and to keep each one standard, not only as to size, but as to its form, is often a difficult matter. With this system a master hob is demanded for each style of thread, such as, V. Whitworth, square, 29-degree, 45-degree, and U. S. Standard. Such a hob will, with with proper care, last a lifetime, and will insure all of the different styles being kept to their proper form, which is a very essential point in thread cutting.

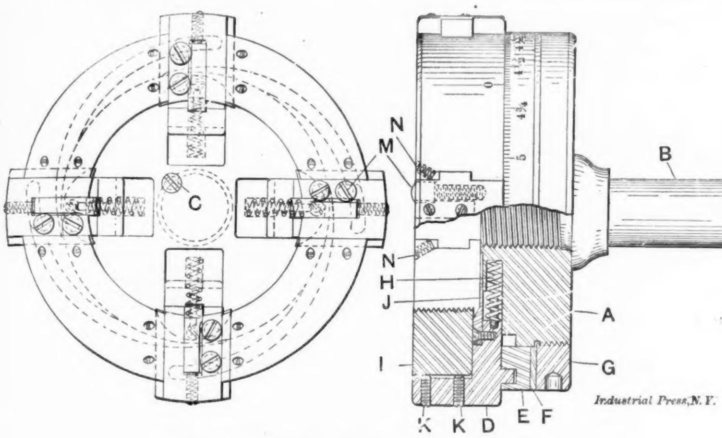


Fig. 1. Combined Adjustable Die and Holder.

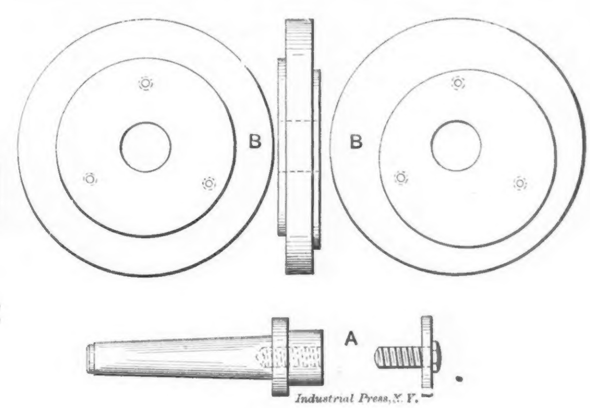


Fig. 3. Arbor and Plate for Milling Cam Ring.

Fig. 1 illustrates what is termed an adjustable die and holder combined, and its sphere of usefulness can be appreciated, as it has an adjustment of one and one quarter inches and its threaders are very simple to construct, thereby making them inexpensive to renew. They may easily be made of high-speed steel, which has proved far superior to the regular tool steels when it is properly hardened. The body, *A*, is made from a piece of forged steel, onto which the shank, *B*, is screwed, being locked into place by the screw, *C*, one-half of which is in each piece. The shank is made of low-carbon steel and is hardened. The four jaws, *DD*, are made of machine steel, casehardened, and are a good fit in the body, *A*. Gibs and gib screws, *N*, are utilized to compensate for wear. On the lower part of each jaw is a projection which engages a slot in the cam ring, *E*. The construction of both jaw and cam ring will be more clearly seen by reference to the details shown in Fig. 2. The threaders, *I*, *I*, fit into these jaws and are held by the screws, *MM*, while adjusting screws at the back of the threaders allow for resetting after they have been rehobbed. The springs, *H*, serve to always hold the jaws against the top of the cam groove, thus insuring accuracy. To protect these springs and the inner part of the slot from dirt or chips, when the jaws are set at their largest diameter, the pieces marked *J* are used, being held fast in a slot milled into the jaw, by means of a screw located at the bottom of the threader slot. They are fitted into the body, *A*, so that they will move in and out with the jaw, and are flush with the bottom of the body.

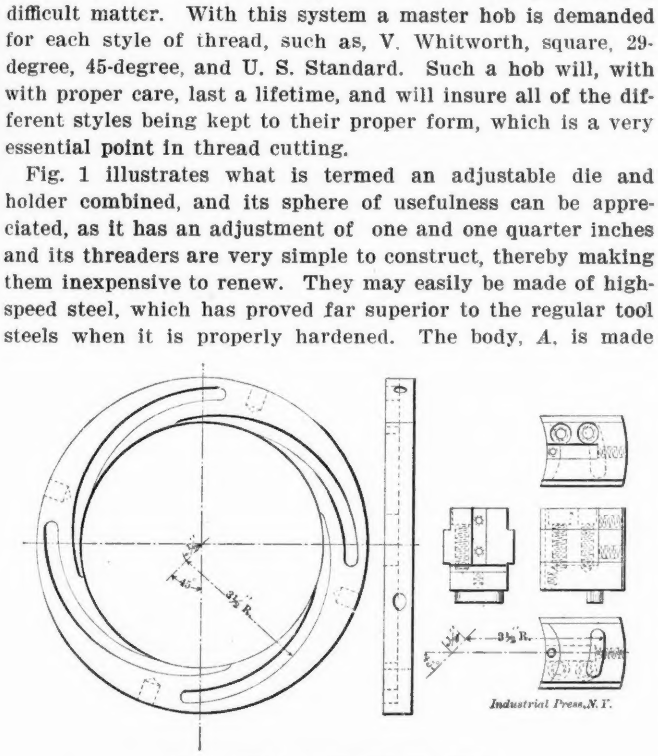


Fig. 2. Detail of Cam Ring and Jaws.

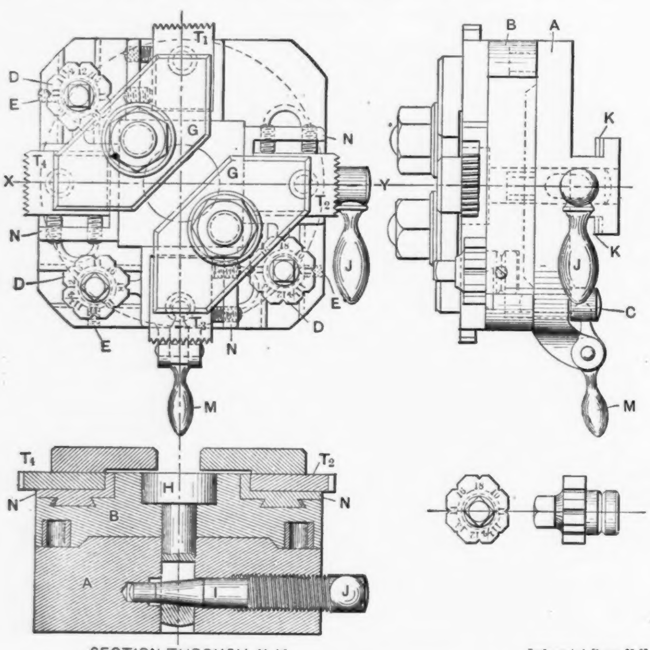
The cam ring *E*, from which the 1¼-inch adjustment is obtained, has four cam grooves, the milling of which presented some little difficulty, but was finally accomplished by use of the special plate and arbor shown in Fig. 3. The shank of this arbor was made to fit the dividing head of the milling machine, and the projecting head was turned to a sliding fit in the plate *B*, and tapped on the end to receive a bolt by which the plate was clamped in position. This plate served as an arbor for milling the cam rings. As will be seen from Fig. 2, these cam grooves are struck from a center which is one-half inch off from the center of the ring, and with a radius of 3½ inches to the further side of the groove. One side of the milling plate, *B*, is turned to fit the cam ring and is concentric with the plate, and on the other side there is a similar projection which is one-half inch eccentric and holds the rings while the grooves are being milled. The plate is first placed on the arbor with its concentric side outward, and to this the cam ring is secured by three screws fitting into the plate. With a graduating tool in the milling machine spindle, and the arbor placed in the dividing head, four equally spaced lines are graduated on the inside of the ring. The ring and plate are then removed from the arbor, the ring taken off and the plate replaced with its eccentric side outward. A line is graduated on the plate so that it will bisect the eccentric boss. The cam ring is then replaced on this side, with one of the four graduations in line with the zero line on the plate, being secured with the three screws as before. The milling machine table is first raised so that the center of the spindle is in line with the center of the dividing head, and is then lowered just 3.344 inches, which amount, with a 5-16 inch cutter, gives a 3½ inch radius on the largest diameter of the cam groove. After the first groove is milled, the ring is released and revolved around on the plate to its next graduation for the second groove, which, with the third and fourth, are all milled in the same manner as the first.

The threaded ring, *G*, Fig. 1, serves to lock the cam ring in position by pressing against the washer, *F*, which is kept from revolving with the ring by a small key set into the body, *A*, and fitting a spline in the washer. It is well when replacing threaders to always adjust them so that the diameter threaded by them will correspond with the graduation which is upon the outer diameter of the cam ring.

The method adopted for making the threaders necessitated the fixture shown in Fig. 4, which was made for use on a lathe with a hob placed between the lathe centers. This hob should be made a trifle larger in diameter than the largest size that is to be cut with the threaders, as a set of threaders that is used on work 4 inches in diameter will not work prop-

erly when hobbed with a 3½ inch hob, since the heel of the thread would drag. One hob of a certain pitch will answer for hobbing all threads of the same pitch, provided it is in all cases larger in diameter than the work that the threaders are to act upon.

The body of the fixture is made in two parts, *A* and *B*, the part *A* fitting the tool-post T-slot in the lathe carriage, and being held securely by the two taper keys *KK*, each being placed in position from the opposite sides of the carriage. In the front side of *A* is a hardened and lapped bushing carrying the index pin *C*, which enters four similar bushings equally spaced in the part *B*. By rotating the part *B* and letting the pin *C* engage with each of the bushings successively, the threaders, which are fastened to the top of the part *B*, are brought into position for hobbing. As there are four threaders in the die it is necessary to have them located on the fixture at different distances from the center line; as, for example, in hobbing a threader for a ten-pitch thread, threader No. 2 would be located .025 inch off from the center line, which equals $\frac{\text{Pitch}}{4}$, threader No. 3 would be .050 off, or $\frac{\text{Pitch}}{2}$ and threader No. 4 would be .075, or three times that of No. 2.



Industrial Press, N.Y.

Fig. 4. Jig for Hobbing Threaders.

This is accomplished on the fixture by having the threaders T_2, T_3, and T_4 held in movable jaws, *NN*, which are kept in alignment by fitting dovetails in the body, *B*. On the front side of jaws Nos. 2, 3, and 4 there are projections which bear against dials *DD*, being held always in contact by means of small spiral springs. (Springs not shown in the drawing.) These dials are made of tool steel and are shown in detail in corner. They are fitted with a square head so as to be revolved with a socket wrench. A special milling cutter was made for milling these dials. It had a 90-degree projection upon it, and the slot which it formed in the dial was employed for locating the jaws by means of a similar projection on them.

	Threads per inch.							
	10	11	11½	12	13	14	16	18
Dial No. 2.	.0250	.02273	.02174	.02083	.01923	.01786	.01563	.01389
Dial No. 3.	.0500	.04546	.04348	.04166	.03846	.03571	.03125	.02778
Dial No. 4.	.0750	.06818	.06522	.06249	.05769	.05357	.04688	.04166

NOTE.—Subtract figures of table to obtain difference of dial steps.

Table showing Difference of Settings for Milling Dials.

As will be seen, the dial is divided into eight parts, each being marked with the pitch of the threader which it is to locate. The milling of the dials was accomplished by raising the table of the milling machine the proper amount for each division, the table placed below the detail showing the difference that must be made on each dial, with the corresponding number of threads per inch. The figures are stamped upon the dials before they are milled, so as to avoid any mistake. The dials are held in position in the fixture by means of a small screw, *E*, with a 90-degree point, which fits a slot in the shank of the dial. When the threaders have been located in position they are held securely by the two clamps *GG*.

The cross sectional view of the fixture shows the device that is employed for locking the parts *A* and *B* together. In the central stud, *H*, is an elongated hole through which passes the tapered pin *I*, and when this pin is turned by the handle *J*, it bears against the bottom of the hole in the stud and clamps it firmly. To operate this fixture we first unscrew the handle *J*, and thereby withdraw the taper end of the pin partly out of the hole in the stud, so that it loosens up the part *B*. The index pin *C* is then withdrawn by pulling up on the handle *M*, and the head is revolved a quarter of a turn. A spring attached to this handle causes it to spring into the bushing as soon as it is brought over it.

Another method for accomplishing the threading of the chasers without the aid of so elaborate a fixture as that just described consists in placing the hob on the lathe centers as before, and having a faceplate arranged with as many slots as there are threaders in the die head, care being taken that the slots are equally spaced. A simple fixture is placed on the lathe carriage to hold the threaders in position, and the threaders are numbered as they are cut, the slots on the faceplate having corresponding numbers. After threader No. 1 has been hobbed, the hob is released from the centers and revolved so that its driver will engage slot No. 2 on the faceplate. No. 2 threader is then placed in the same position as was occupied by No. 1 and is hobbed in the same manner. Nos. 3 and 4 are likewise hobbed, using the driving slots corresponding in number. In both of these methods it is understood that the lathe is geared to cut the same number of threads as there are upon the hob.

* * *

A drawback to the general use of nickel steel is the high price of nickel, which is now about 35 cents a pound. This in effect adds $10 to $12 a ton for each per cent. of nickel used, but as the nickel can all be recovered from the scrap, part of the extra cost may be regarded as an investment to be eventually recovered. As interest the user gets wonderful durability under severe stresses, which is especially apparent in locomotive and car axles. The average of forty tests on nickel-steel axles made for the Pittsburg, Bessemer & Lake Erie R. R., which, by the way, has four thousand nickel-steel car axles in use, showed that 67 blows of a drop weighing 1,640 pounds, and falling a distance of 44 feet, were required to break a nickel-steel 5 x 9 inch car axle having a diameter of 5⅜ inches in the middle. These axles contain carbon, 0.26 per cent.; manganese, 0.75 per cent.; and nickel, 3.25 per cent. The deflection after the first blow was 5.2 inches. The Pennsylvania R. R. standard requirements for 5 x 9 inch axles are 5 blows of 1 640-pound drop from a height of 43 feet and a maximum deflection in the center of 5.5 inches.

* * *

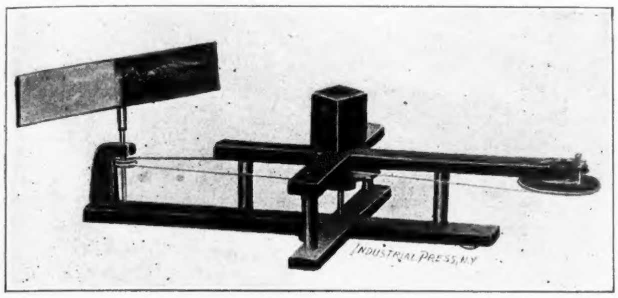
An interesting statement bearing on the future of great cities was embodied in an address recently made by Prof. H. B. Smith of the Worcester Polytechnic Institute, speaking of electrical transmission of power. He said that in San Francisco a few years ago the cost of electric current for power and light was 15 cents for one horse power per hour, while to-day the published price is almost exactly one-seventh of this amount, and it is possible to deliver at the factory on the coast, from the melting snows and glaciers of the Rockies, power for the machinery at a smaller cost than that at which it is possible to produce that power by steam, even though the fuel were to be delivered at the factory boiler without cost to the power producer. It has been estimated that the quantity of carbonic acid annually exhaled by the population of New York city is about 450,000 tons, and that this amount is less than three per cent. of that produced by the fuel combustion of that city; so we may expect that, with the removal of this great source of contamination of the atmosphere, even the air of our greater cities will be practically as pure as that of the country.

LETTERS UPON PRACTICAL SUBJECTS.

SOMETHING FOR THE HOLIDAYS.

Editor MACHINERY:

I am sending herewith photograph of a revolving Christmas tree holder, which you may find appropriate for your December number of the paper. I used the device last Christmas and it worked very satisfactorily. The frame carries a central, vertical rotating spindle, which supports a block for holding the base of the tree. At the right is a clock movement for furnishing the power and at the left a fly governor for regulating the motion of the tree and clock movement. I fitted the device with an old alarm clock movement, taking all the wheels out except the ones attached to the spring axle and to the main axle, which geared together. The wooden pulley below the movement was attached to the main axle of the works, and a cord led from this pulley to a small pulley on the central spindle supporting the tree. A large pulley, also, on this spindle drives the governor shaft by means of a cord, as shown.



Apparatus for Revolving Christmas Trees.

In making a mechanism like this, it would be well to have the governor wing a little lower down so the lower branches of the tree will clear it. The one that I have made will turn a medium-sized Christmas tree for from 20 to 25 minutes before it is necessary to rewind the clock spring. It is possible that some of your readers, who intend to celebrate Christmas by means of a tree for the younger members of the family, would like to make a revolving Christmas tree holder like this one.

MAX SCHILLING.

St. Paul, Minn.

WHAT CAUSED THEM TO BREAK?

Editor MACHINERY:

The accompanying photograph illustrates two reamers that broke in hardening and it is hoped that they will call forth some opinions as to the cause of their doing so. They were made of the very best of tool steel purchased from one of the leading steel manufacturers especially for this purpose.

Reamers Broken in Hardening.

The dimensions were as follows: Length of taper 7 inches, length of parallel shank 6 inches, largest diameter 4½ inches, smallest diameter 3½ inches.

The reamer at the right was made first and this split lengthwise and in a few hours the shank broke off. The toolsmith was so confident that he could temper another successfully that a second one was made and this broke crosswise at about one inch from the large end, as shown at the left of the cut. A third one was then made with a taper hole throughout its entire length, two inches in diameter at the large end and having the same taper as the blades of the reamer, a shank being made later to fit it. This one came out of the hardening in good condition and is now in use.

It may be said that the smith was a very reliable man, of wide experience in this line of work, with which he is usually successful. The reamers were heated slowly and evenly in a charcoal fire and dipped in warm water—in fact, they received exactly the same treatment as has been given to other reamers by the same man with excellent results. Now I would like to hear from some of the readers of MACHINERY as to what they think was responsible for the breaking; whether the trouble was with the steel, the toolmaker or the smith. I have a theory of my own which may be submitted later.

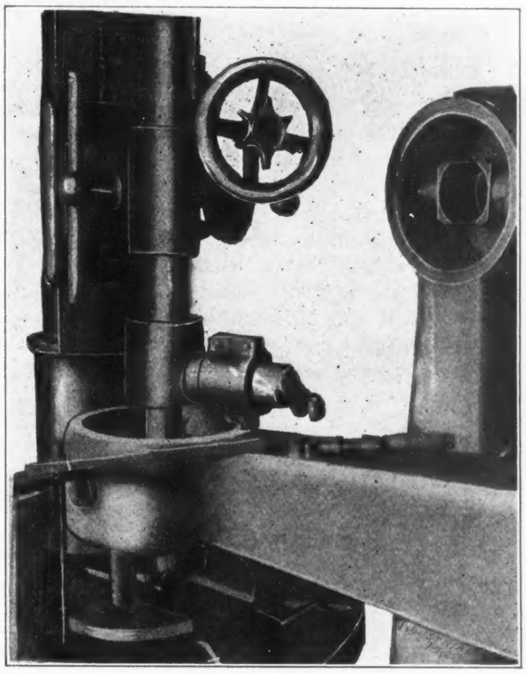
M. H. WESTBROOK.

Port Huron, Mich.

LARGE FACING WITH AN UPRIGHT DRILL.

Editor MACHINERY:

While we are all interested in well equipped shops, and special machines are being put into use for facilitating work, it is doubtful if the time will ever come when it will not be necessary, at times, to use machines for work which was not intended for them. The accompanying photograph shows a job of this nature which was done in a 27-inch Barnes upright drill. A motor field, integral with the column of the



Facing Motor Columns on an Upright Drill.

machine, is being bored and turned where the hood carrying the other bearing fits on. The hole for the front bearing case is 4¼ inches in diameter, as is the bore of the steel pole pieces, and the surface on which the tool is shown at work in the photograph is 11 inches in diameter. The tool is 5-16 inch square and is held directly in a socket provided for it in the sleeve which slides upon the radial arm. This arm forms one piece with the hub that is clamped on the end of the drill spindle. The boring bar is shrunk in this hub and has a bearing in the drill table.

The writer believes that some attempts at large diameter work in the drill press are failures because the tang of a taper shank bar is depended upon to drive the cut. In the arrangement shown here this is not used but all driving is done by the outside of the enlarged end of the spindle. The feeding of the tool radially is done by hand as the surface is but ⅞ inch wide and there would be no advantage in having a power feed, although a star feed could easily be provided.

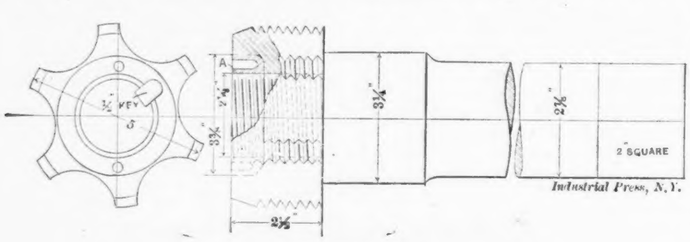
Another peculiarity of this job is that the work is held firmly onto the drill table by pouring babbitt around two projections on the casting and into two slots in the drill table. The close proximity of the drill press to the babbitt bench renders this a good way of holding the pieces. Two light clamps help to secure the work, and that it is held as solidly as if it were one piece with the machine need not be doubted. About fifty motors have been machined in this way and it has not been found difficult to do a true job in a very fair time. CORNEIL RIDDERHOF.

Grand Rapids, Mich.

DETAIL OF LARGE SHELL TAP.

Editor MACHINERY:

The writer noted with interest the account in the October number of MACHINERY of H. H. E.'s accident in hardening a large tap. The accompanying sketch shows the form of tap that is used at the Cramp Shipbuilding Co. for taps of the size described by H. H. E.; no tap over 4 inches in diameter ever being made from the solid. Taps of this design have been made in sizes up to 6¼ inches in diameter, four threads, and have given very good results. The shank of these taps is made of mild steel and can be of any length that is convenient.



Large Shell Tap.

The tap proper, or shell tap, is held to the shank by a spanner nut, *A*, which fits the end of the shank and a key is used to keep the shell from turning on the shank. The sketch shows the dimensions which would apply to a 5-inch tap. Other sizes would be in proportion and several sizes of tap shells may be made to be used on the same shank.

While there is much that is to be said about taps a great deal depends upon the quality of the steel that is used for making them. Although they will sometimes crack and break with the most careful treatment, if good stock is used good results will usually be obtained. F. HARRISON.

Philadelphia, Pa.

SPIRAL GEAR-CUTTING MACHINES.

Editor MACHINERY:

I am able to furnish some of the information desired concerning the spiral gear-cutting machine illustrated in your issue of November.

The reason that the machine is not made in this country is that I hold a patent upon it. I am not making it myself because I am not a machine-tool builder, and cannot induce any manufacturer to take it up for me. The patent will probably run out its term unused.

It is only fair to intending purchasers to record my claim that the Biernatzki & Co. machine which you illustrate is a direct infringement upon my patent, and that anyone who purchases one without a permit from me is liable to be called to account by my lawyer. The machine, as made by this firm, is patented in this country by Phauter, and a most cursory examination of his patent of January, 1900, will show that his invention is fully included in mine and covered by my claims.

My patent is disputed by several concerns who imagine that it is cheaper to steal my invention than to purchase it, but it is to be noticed that every one of these concerns has adopted the futile device of secrecy. They have the machines working in locked rooms, out of sight, and imagine them out of reach. When the patent runs out these machines will blossom forth as brand new. Not one of these infringers will discuss the matter of validity, for the simple reason that they have no argument to offer. I am preparing a suit against one of them which will test the matter. Intending infringers and importers of infringing machines will do well to wait the decision of the court in this test case.

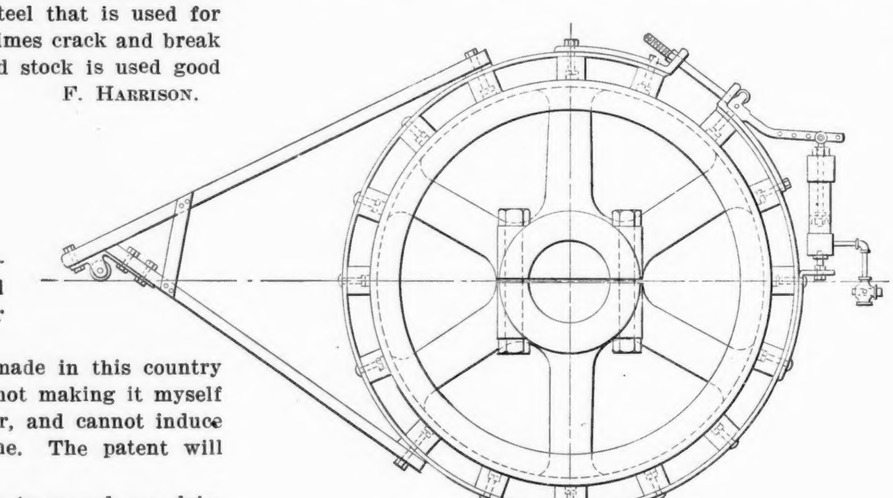
That the invention is practical is proven by the uniform success of the machine when properly made. I do not doubt that it will appear under names of Smith or Jones, or otherwise, as soon as my patent is out of the way, and that it will be the future method of cutting spur and spiral gearing in regular manufacture. It is not very well adapted to the jobbing trade, but for turning out gears in rows by the hundred it is the coming thing. The machine is described in my Treatise on Gear Wheels. GEO. B. GRANT.

A QUICK-ACTING ATTACHMENT FOR THE PRONY BRAKE.

Editor MACHINERY:

The office of the Prony brake in connection with the testing of dynamos, motors, steam and gas engines is to hold a load on a band wheel used in connection with the brake band. The load is maintained constant by the use of a wrench or hand wheel with which the band is tightened or loosened as the case may require. This method is, however, by all means too slow for obtaining good results when variations of the load are often from 0 to 125 per cent. overload and take place so rapidly that hand regulation would be impossible. The accompanying sketch shows a brake which is fitted with a quick-acting attachment that makes it suitable for this kind of testing.

A small cylinder, having a diameter of about three inches, is fastened to one-half of the brake band and to the upper end of the piston rod is connected a short lever which supports a cam on the end toward the band. Power, which may be either steam, hydraulic, or compressed air, is supplied to the cylinder by a ⅜-inch pipe entering on the lower side of the piston. When pressure is admitted to the cylinder the piston is forced upward and consequently imparts an upward motion to the short lever on the end of the piston rod. This causes the cam on the end of the lever to close the band and to hold the load at any desired point, this being regulated by the amount of pressure that is admitted to the cylinder. In order to make this application complete and at all times under control of the engineer, a ⅜-inch plug cock of ordinary style has been placed in the supply pipe line at whatever point is the most convenient for operation. This cock has a 5-16-inch hole drilled through one of its sides and a similar one drilled half way through the plug, thus forming an outlet on the cylinder side of the cock for release of the pressure in the cylinder. Thus it will be seen that closing the cock to pressure opens it to release and the pressure in the cylinder immediately falls. In using this arrangement from 1 to 500 horse power can be instantly applied by simply moving the lever on top of the cock, and release is as easily obtained.



Prony Brake with Quick-acting Attachment.

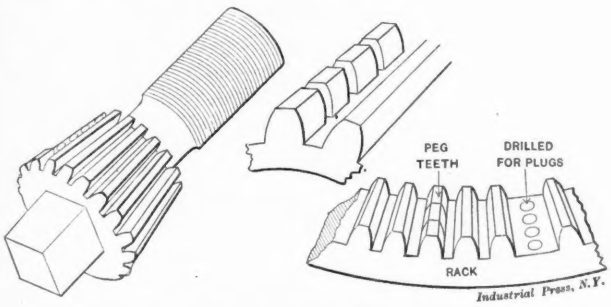
Oswego, N. Y. JAMES H. TAYLOR.

THE TOOLMAKER IN THE SMALL SHOP.

Editor MACHINERY:

Among the many odd jobs that come to the toolmaker in the small shop is the taking out of broken taps and setscrews from various pieces of work. Of course it is careless on the part of the workman, or so the toolmaker thinks, forgetting that he broke a small tap himself in the very last job he made, but it has to be fixed just the same, and so he goes at it.

If it is a tap or a hardened setscrew the first operation is to draw the temper so it can be drilled easily, and the best manner of doing this depends on the kind of a piece it was broken off in. When it's a small tap in a big piece of work



Repairing a Geared Chuck.

that you don't want to heat all over, the temper can sometimes be drawn with a blow-pipe, playing the flame directly on the broken piece. It is better, however, to get it as soft as possible so as not to make the drilling out hard or to increase the tendency of the drill to run into the softer metal, in this case, the work.

In the case of a setscrew you can sometimes drill out so close as to leave nothing but the thread in the holes, and this can then be easily removed. This cannot often be done, however, as it is difficult to keep the drill running true enough to avoid cutting away the thread on one side or the other. It is decidedly safer to use a drill that will leave about a sixteenth of an inch on a side. Then, unless the setscrew is a particularly tight fit, a square punch can be driven into the hole firmly enough to unscrew it with. If, as is usually the case, the setscrew was broken from setting it up too tight on a shaft, this pressure will be relieved when the drill reaches the end of the screw, even if it does not drill through into the shaft. The square punch usually takes them out, but at times it is necessary to split the shell which remains, with small cape chisels. A careful man can usually get them out without much damage to the tapped hole. Where damage cannot be avoided it is often necessary to tap the hole out with a larger tap. I believe this practice is largely responsible for some of the odd sizes we find in some shops.

Practically the same treatment is needed in the case of a broken tap, but more care is generally required. A small hole is necessary owing to the grooves cut into the sides, and this makes it harder to remove the broken piece, as there is such a small chance of getting a good grip with a punch driven into the hole. It is a mean job at best, and a man who has had the pleasure of drilling a tap out of a piece of work will be almost unduly cautious for some time to come.

Another job that isn't altogether pleasant, though preferable to the drilling out of taps, is that of playing at dental surgery with the teeth of geared chucks or other gear teeth. The universal chuck is perhaps more largely used in brass work than any other line, and the brass chips find their way into the internal regions of the aforesaid chuck with great rapidity. Then they wedge into the teeth and in an unguarded moment the operator gives a little extra pull, snap! go a few teeth of either the pinion or rack (usually the former) and the chuck is on the repair list again.

The toolmaker takes it apart, locates the damaged teeth, and goes to work by drilling a row of holes fairly close together, as shown by the illustrations. The width of the teeth at the base determines the diameter of the holes, and he files or chips the broken tooth to a fairly level base before drilling. Then he takes steel wire rods—either Bessemer or drill rods—and drives into the holes, leaving a little extra length to file off for a finish. The next step is to file up the sides as nearly like the teeth in the pinion or rack as possible, although at best it is enough to make a regular gear man shudder. But they do the work and the false teeth almost never break, even when made from Bessemer rods.

Putting the chuck together again so it will run true isn't such an easy matter unless you've been there before. The quickest and surest way is to first put it together without the rack. Put it on the lathe where it belongs and, using it as an independent chuck, true up a mandrel or other round piece in it. Leaving this tight in the jaws, take off the back, put the rack in place and put together again. It will generally be found to run true after this, although there may be slack enough in one pinion to throw that out a little. If so, this particular pinion probably needs to be turned one tooth in one direction or the other to make it right. One thing is certain, if it ran true before you commenced your dental operations, it can be made to again. In many ways the universal chuck for anything larger than a drill chuck, is a delusion and a snare. As any mechanic who has handled them knows, it is a miracle when they run true for any length of time and they are weak as compared with an independent chuck.

It is also true that much of the trouble with chucks of this class comes from improper handling. If you attempt to tighten a piece of work from one screw, as you might do in a three-jawed independent chuck, you are very apt to have trouble. Either the teeth will break out or the work will not be firmly held.

The man who has had experience of this kind, tightens up on one screw until he grips the piece, then he turns the lathe and tightens each screw separately, perhaps two or three times. This uses the rack simply to bring the jaws to the work and tightens by each screw as it should.

Repairs can also be avoided by cleaning universal chucks occasionally—not to wipe out the oil, as they are generally kept dry on brass work, so the chips will not stick, but to clean out the little chips and brass dust. These pack into the teeth and cause trouble. For cleaning, just clamp a piece into the jaws, take off the back, get out the dirt and put back the rack and other parts removed. This keeps the jaws just where they were and saves any readjusting.

FRED. H. COLVIN.

SOME MORE MICROMETER MEASURING INSTRUMENTS.

Editor MACHINERY:

That micrometer lathe stop which was shown by Mr. Cantelo in the July number of MACHINERY is certainly a good one, but the writer takes the liberty of suggesting an improvement in its construction. Without doubt this is one of the most accurate and universal tools in use, but the description

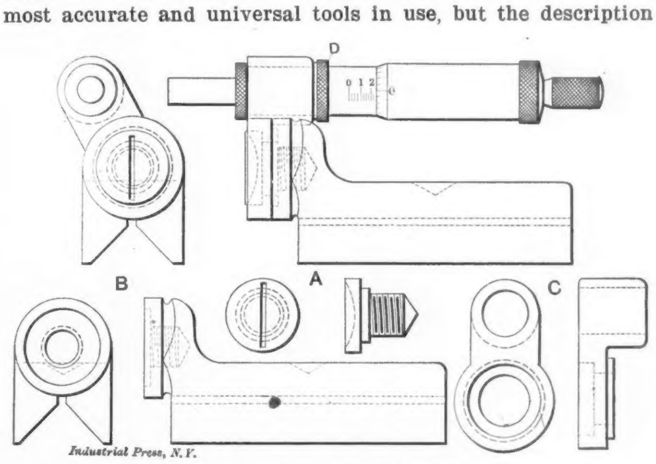


Fig. 1. Micrometer Lathe Stop.

referred to showed an instrument that is limited in its use to work where only a stationary height is required. It is, however, often necessary to use the stop at different heights, to accommodate different lathes; then again, we wish to use it on the right-hand side as well as the left. The form of holder shown in Fig. 1 can be used either right or left, and for various heights and, by simply taking out the screw, *A*, the micrometer may be removed and used in any other form of holder desired.

Both assembled view and details of the holder are shown in the figure so that it can be easily constructed by any one desiring to do so. The micrometer and barrel may be procured from any of the manufacturers of measuring instruments. The swivel *C* is bored out so that the axis of the micrometer screw will be parallel to the body of the holder

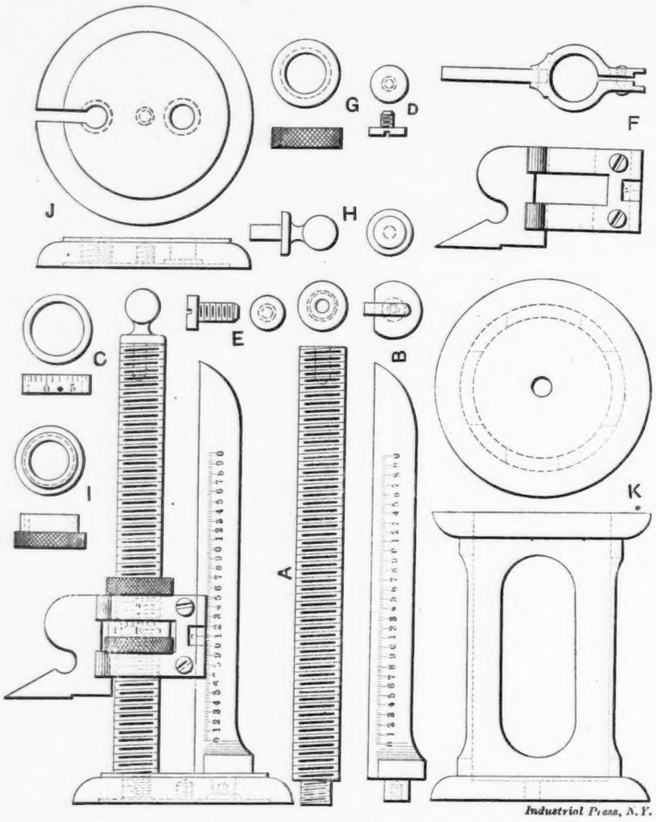


Fig. 2. Micrometer Surface and Height Gage.

when it is in place. The swivel is made of tool steel and is fastened to the holder by the screw *A*. It is hardened and lapped to a true bearing surface on the sides and bottom and so adjusted that it will turn to either side and remain in desired position without moving the screw. The holder *B* is milled through its entire length with a 45-degree cutter so that it will fit along the ways of the lathe, and the bottom is lapped to a true surface. For a neat appearance it should be color hardened. On top of the holder the point of a drill is entered a short ways to form a recess for the *C* clamp. A knurled ring *D* is driven onto the micrometer sleeve so that it can be turned around to bring the graduations uppermost when the position of the barrel is changed.

Fig. 2 shows a form of surface gage that has proved very handy and can be used also as a height gage for measuring distances from shoulders to the base. If accurately made it is equal, and often preferable, to the vernier or slide caliper now so generally used with an attachment to the sliding jaw. One of its advantages over the vernier is the readiness with which the graduations are discerned, and it is as easy to manipulate as the ordinary micrometer. The part *B*, which forms the main body of the instrument, is made of tool steel and one end is fitted into the base where it is held in position by the screw *D*. The other end is milled to a thickness of 1/8 inch and has graduations of .025 inch for a distance of three inches. The screw *A* is the most essential part of the tool and its construction requires great accuracy. Its diameter is 1/2 inch and it is cut with 20 threads per inch. On the upper end of the screw is driven the ball *H* for the sake of giving a neat appearance. The top of the thread is turned off .01 inch to allow the scriber *F* to slide freely on the screw. The barrel *I* is used for raising and lowering the slide but instead of having the graduations placed directly upon it they are made upon the sleeve *C*, which fits over a shoulder on the barrel. This allows for more easy means of adjustment than would be possible were the graduations placed on the barrel itself. The sleeve is graduated with fifty divisions each equaling a movement of the scriber of .001 inch. This sleeve may be turned by means of a small spanner wrench so as to bring the zero line into correct position to compensate for wear. A knurled locking nut is also provided for holding the scriber in any fixed position. The scriber itself is hardened and lapped to a finished surface, the tail end being slotted and provided with two screws to compensate for wear. On the scriber is placed the zero mark which shows at a glance the measurement that is being taken. The block *K* is three inches in height and is so constructed that by placing the gage on its top the range of the gage is increased to six inches. The screw *E* is used for fastening the gage to the top of the block. The center of the block is drilled out and slots cut through the sides in order to make it light and neat in appearance.

Fig. 3 shows a very simple and light five-inch micrometer that can be quickly set to exact position from one to five inches. The round beam is graduated by a series of angular grooves, 1 inch apart, which are of such a form and depth that the clamping fingers at the end of part *A* spring in, allowing one inch adjustment of the beam to be quickly and positively made. The sleeve *K* is of tool steel, being counterbored from the forward end for all but one-half inch of its length. For this half inch it is threaded on the inside and acts as a micrometer nut. The outside of the same end is threaded to receive the adjusting nut *F*, and two slots are cut in the sleeve, at 90 degrees with the graduations, so that these, by a movement of the nut *F*, provide a means for compensating for wear. The bushing *E* is hardened and lapped, and fitted tightly in the forward counterbore of this sleeve where it acts as a guide for the front end of the micrometer screw. The barrel *J* is the same as that of a regular micrometer and is graduated in .025 inch divisions.

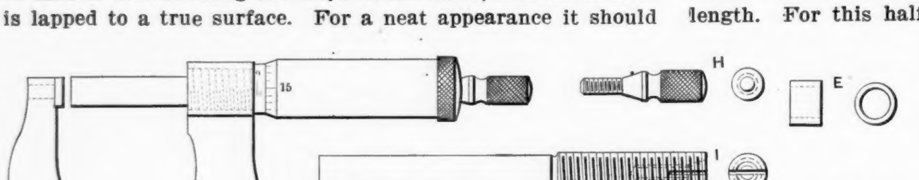


Fig. 3. Five-inch Bar Micrometer.

The most essential part of the tool is the threaded screw *I*, over the end of which fits the barrel *J*. The end is tapped out to receive the speeder *H*, which serves to hold the barrel in position. The thread is 5-16 inch in diameter and threaded 40 pitch, while the unthreaded part is hardened, ground and lapped. To adjust the instrument, loosen the speeder *H* and turn the barrel until the proper adjustment is obtained; lock the barrel by again tightening the speeder. The beam *C* has a 1/4-inch hole drilled throughout its entire length in order to make it light. Small 90-degree grooves are cut into it at intervals of 1 inch, and a 1/8-inch slot is milled through one side to within 1 1/4 inch of the forward end. The back end of part *A* forms a spring-tempered split chuck, which grips the

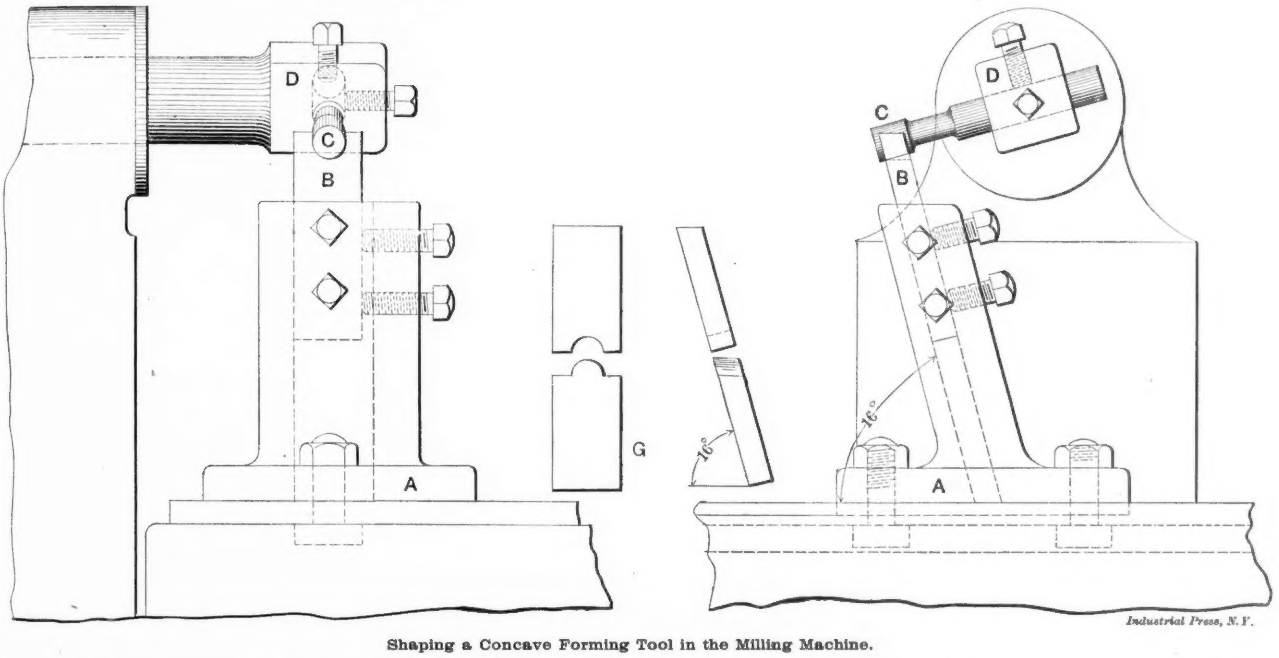
beam and holds it in position, while the exterior is threaded to receive the knurled cap *B* by which the chuck is tightened firmly to the beam. From the front end, toward the split chuck, the body is counterbored ⅝ inch and the bushing *D* driven in tight. This bushing has a key *G* fitted into it which slides in the slot of the beam and prevents the arm from turning. The projecting arm is bored and tapped to receive the sleeve, *K*. This gage has proved one of the writer's handiest tools but it must be carefully and accurately made to be of value.

New Haven, Conn. A. L. Monrad.

MAKING A CONCAVE FORMING TOOL.

Editor Machinery:

The accompanying drawing illustrates a method of making a concave forming tool such as is used for backing off convex milling cutters. This tool is required to have the same shape for its entire depth so that it may be ground and reground without changing its original form.



Shaping a Concave Forming Tool in the Milling Machine.

In the sketch, *B* represents the tool which is held in the holder *A* at an angle of 16 degrees with the table of the machine, this inclination giving to the tool the proper cutting clearance. The first thing to be done, after placing the tool in the holder, is to mill off the top of the tool so that it will be parallel with the table of the machine. A semicircle of the desired radius is then drawn on the back of the tool and with any cutter that is at hand, it is milled nearly to the mark, care being taken not to go below it. For finishing the cutter a plug, *C*, is made, the end being hardened and ground in a surface grinder. This plug is held in a special holder, *D*, which fits the spindle of the milling machine, and when it is set so that its axis is perpendicular to the tool the spindle of the machine is firmly locked. Some machines are now being built with provision for locking the spindle, but if not so made the same result may be accomplished by driving wedges under the cone pulley. Now by moving the platen of the machine backward and forward by hand the plug can be made to cut a perfect semicircle in the tool.

It is good practice to plane a little below half of the diameter of the plug, thus allowing some stock to be ground off after the tool is hardened. In hardening, these tools usually come out very satisfactorily, but if any distortion takes place it will be from the sides and may be readily remedied by a little stoning.

By using the concave tool for a planing tool, as shown in the sketch at *G*, a convex tool may be formed, but in doing so care should be taken that both tools stand at an angle of 16 degrees with the bed of the machine. This shape of tool would be used for backing off a concave cutter.

Providence, R. I. J. J. Lynskey.

A TIME-SAVING DRILL JIG.

Editor Machinery:

The drill jig which is here illustrated and described had considerable influence in establishing the cost of production, and maintaining the uniformity of the piece shown in Fig. 1, and although there is nothing remarkable in its construction, it embodies one or two points of interest since it is rigid and simple and is designed to withstand the severe handling that a tool of this kind usually receives from unskilled workmen, and at the same time it is capable of producing very satisfactory results. The pieces are first turned in the lathe to the proper size and length and the hole through the center is drilled at the same time. The object of the jig is to drill the side holes and the two end holes, which are diametrically opposite, one of them being stopped off at ⅛ inch from the bottom and continued through with a smaller size of drill.

This jig, which is shown in Fig. 2, consists of an L-shaped casting, *A*, which is supported on its bottom or side by the steel legs, *BB*, the faces of which are hardened and lapped true. A hole is drilled straight through the jig from top to bottom and into the top of this hole is forced the bushing, *C*, of tool steel, having a No. 19 and a ¼-inch hole, also a guide for one end of the work projecting at the center on the lower side. This is forced into the jig from the inside until the shoulder bears firmly against the upper arm of the jig. This combined bushing and guide was made in a single piece, instead of inserting drill bushings and a guide piece separately, because the variation allowed for the holes was greater than any that was likely to be incurred in the hardening of the piece.

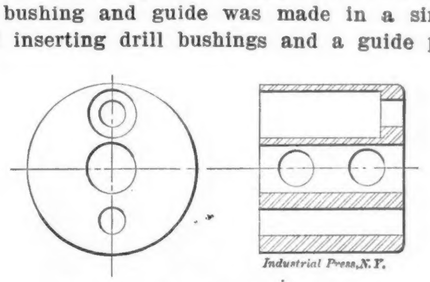


Fig. 1. One of the Pieces to be Drilled.

Fitted tightly in the hole in the base of the jig is the sleeve, *D*, which carries a traversing piece, *E*, with a guide point on one end directly opposite and like the one in the upper bushing. These guides fit the hole in the work which is advanced or withdrawn by means of the screw, *F*, which is fastened to the piece *E* by the pin, *G*, introduced in such a location that the side rests in a round groove on the upper end of the screw, attaching it thereto and at the same time permitting it to rotate freely. The end of a small pin, *H*,

enters a spline in the side of *E* and checks any tendency that it may have to turn when the screw is being turned. A knurled head is pinned and riveted on the end of *F*, as shown in the cut.

A strip of machine steel, *J*, of sufficient length to extend from top to bottom of the jig, is seated in a square milled channel and fastened by screws and dowel pins. The side holes were carefully located in this strip and two hardened and ground bushings for No. 4 drills were pressed in.

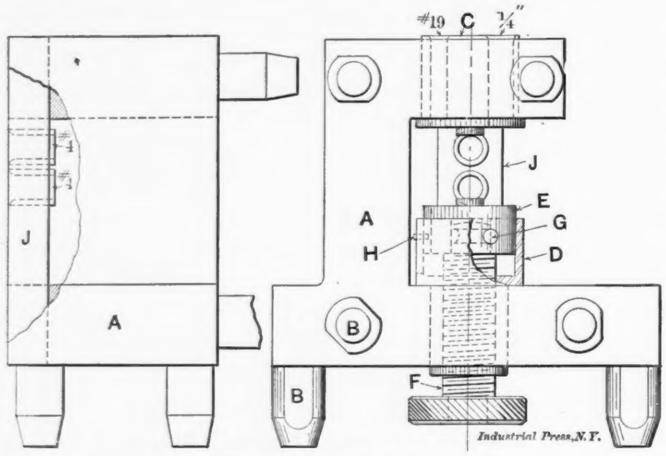


Fig. 2. Jig for Drilling Pieces shown in Fig. 1.

When in use the work is slipped on the upper guide point and, when the piece *E* is advanced by the hand screw, it is held firmly in place, being properly located in relation to the bushings by the center hole. The piece is then drilled as in ordinary jig drilling, the finished piece being removed by simply loosening up the hand screw. The piece, *E*, with the exception of the guide on its end, is left soft for the point of the drills to enter the necessary depth for clearance.

Worcester, Mass. C. H. Rowe.

THE TOOLS FOR MAKING BOX CORNER FASTENERS.

Editor Machinery:

Many of the readers of Machinery are doubtless familiar with the crinkled metallic fasteners that are used for strengthening the sides of boxes after they have been put together, as is shown in Fig. 1, which is a corner of a box into which

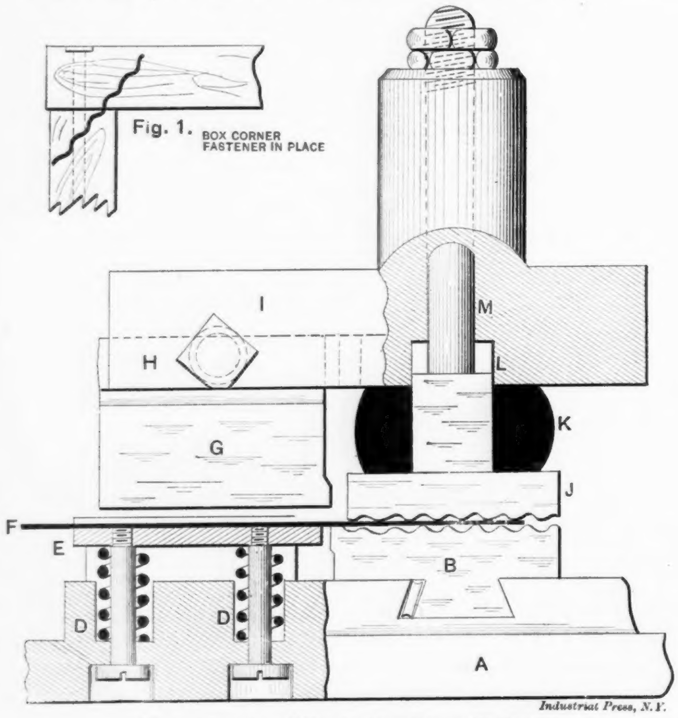


Fig. 2. Punch and Die for Box Corner Fasteners.

one of these fasteners has been driven. These articles are used in large quantities and are sold very cheaply as they are produced in one operation by the means of dies to which the stock is fed automatically. As the manner in which they are made is suggestive for other work of a similar nature, a description of the tools used may be of interest.

In Fig. 2 is shown a front view of the punch and die as they appear when in the press. As will be seen the tools are constructed so as to allow of feeding the metal in strips and producing the finished article in a single operation. In the die, *A* is the die block, which contains the spring pad *E* along which the metal is fed, and the combined cutting off and forming die, *B*. Fig. 3 shows a plan of the punch looked at from below. The punch consists of the usual cast-iron holder, *I*, the cutting off punch, *G*, and the forming punch, *J*. It will be noticed that the cutting off punch is let into a dovetailed channel in the face of the punch holder and fastened in position by the large setscrew, *H*. This allows for the adjustment of the cutting off punch when its face and that of the die *B* are ground. The forming punch *J* is furnished with a stem, *M*, which fits a reamed hole running through the stem of the holder, while the punch proper locates in the channel *L* cut in the face of the holder. *K* is a piece of hard spring rubber placed between the face of the holder and the back of the punch. The punches, *G* and *J*, were hardened and drawn to a dark straw temper while the die *B* was drawn to a light straw.

When the tools are in use they occupy the position shown in Fig. 2. The strip of metal is fed along the face of the spring guide way, *E*, the feed being automatically adjusted to project a certain length of strip across the face of the die at each stroke. As the punch descends this portion of the

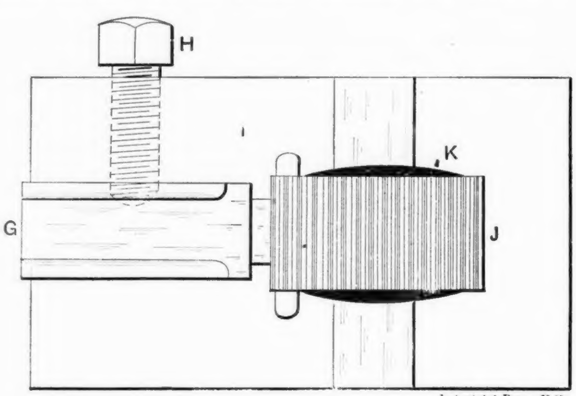


Fig. 3. Plan of Cutting and Forming Punch (from below.)

strip that is to be formed is cut off by the punch *G* and the section is held on the face of the die by the punch, *J*, which remains stationary while the cutting off punch and the spring guide may continue to descend, the rubber compressing meanwhile, until the punch *J* bottoms in the punch holder, when it presses the strip into the desired form. As the press is inclined the finished piece slides off from the face of the die as soon as the punch has risen sufficiently to release it. By the use of these dies the articles are produced very rapidly and cheaply.

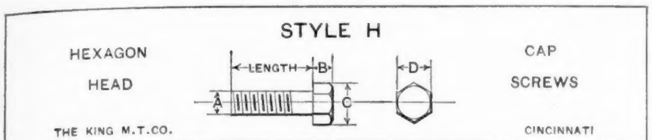
Metal Worker.

* * *

Some beautifully smooth examples of planer work are daily produced at the works of the G. A. Gray Co., Cincinnati, O., especially such parts as have to be scraped and fitted. An interesting kink in this connection may be mentioned. As everyone knows who has had experience in scraping planer work, there may be a great difference between the scraping required on two pieces that appear to casual inspection of the eye to be equally smooth. But the moment a scraper cut is taken over the surfaces, the difference is detected. One may show that little work is required; the other will at once disclose that the surface is a succession of "hills and dales," the working down of which requires a lot of time and labor. When the scraping department is on piecework the men naturally object strenuously to the latter class of planer work. To prevent this trouble in the Gray works, each planer hand is required to place a "telltale" on each planer job that is to be scraped. He does this by taking a few strokes with a broad scraper across the work; if it shows up satisfactorily he removes the job from the platen, but if not another finishing cut must be taken. The telltale is in effect an inspection mark of satisfactory planing.

DESIGNATION OF STANDARD MACHINE PARTS.

The accompanying cuts, Figs. 1 and 2, show sample pages from a book of blueprints used by the King Machine Tool Co., of Cincinnati, Ohio, for designating standard machine parts, such as studs, screws, etc., and which is used in their shop and drawing room practice, and for ordering same from the firms making or dealing in such supplies. The method of



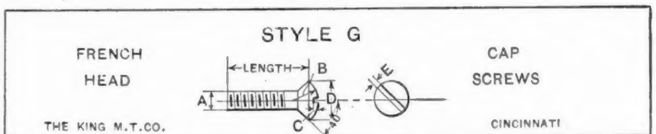
DIMENSIONS				LENGTHS REGULARLY KEPT IN STOCK																			
A	B	C	D	½	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼	4½	4¾	5	5½
5/16	5/16	37/64	½																				
⅜	⅜	21/32	9/16							27													
7/16	7/16	23/32	⅝																				
½	½	⅞	¾				64	65	66														
⅝	⅝	1	⅞				84	85	86	87		89											
¾	¾	1 5/32	1							107		109											120
⅞	⅞	1 5/16	1⅛										130					135					
1	1	1 7/16	1¼																				
1¼	1¼	1 47/64	1½																				
1½	1½	2 5/16	1 31/32																				

Industrial Press, N. Y.

Fig. 1. Specimen Page for Hexagon Head Cap Screws.

designating different screw sizes is of interest and will perhaps be new to many of our readers, although it has been used for some time by a number of concerns, having originated, we are informed, several years ago with the Garvin Machine Co., of New York.

A page of the book, which is simply bound with split staples and marginally indexed, gives the drawing of one style of screw with the principal dimensions designated by *A*, *B*, *C*, *D*, etc.; the name, as "hexagon head cap" in Fig. 1; the style, being "*H*" in this case; and a table of sizes regularly kept in stock. It will be noticed that in the body of the table in this particular case, there are 200 squares, only a few of which have numbers marked therein. These are the sizes regularly used. In this instance the first size regularly used is designated by the number 27. It is a hexagon cap screw ⅜ inch diameter and 2 inches long under the head. The head is ⅜ inch high, 21-32 inch longest diameter, 9-16 inch across flats. All this information is condensed into the symbol



DIMENSIONS					LENGTHS REGULARLY KEPT IN STOCK															
A	B	C	D	E	½	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4	4¼
⅛	3/16	1/16	¼	3/64																
3/16	9/32	3/32	⅜	..		18														
¼	⅜	⅛	½	1/16																
5/16	15/32	..	⅝	..																
⅜	9/16	3/16	¾	3/32			67													
7/16	21/32	..	13/16	..																
½	¾	¼	⅞	⅛																
9/16	27/32	..	1	..																
⅝	15/16	..	1⅛	..																

Industrial Press, N. Y.

Fig. 2. Specimen Page for French Head Cap Screws.

"H27." The number is gotten by counting the number of squares, beginning at the upper left-hand corner and going to the right on each horizontal row, successively downward. Thus it will be found that a ½-inch screw, 1¼ inch long under the head, is designated by the 64th square and its symbol, therefore, is H64. Again, if a ⅜-inch screw is wanted 2¼ inches under the head instead of 2 inches (which is H27) it would be designated as H28, and so on. Fig. 2 shows a page given to oval or French head cap screws. In this case the first size regularly used is 3-16 inch diameter and ¾ inch long under the edge of the head; its symbol is G18. In this case it will be seen that the width of the screw-driver slot is also given.

As already stated, this system is used for ordering stock. Each firm supplying the company with such parts is furnished with a copy of the blueprint book and orders are filled by referring to same. The time required for making out orders is shortened, and the chances for mistakes are lessened. Of course the simplicity of the system on drawings and its advantages in the shop and stockroom are obvious.

* * *

ITEMS OF MECHANICAL INTEREST.

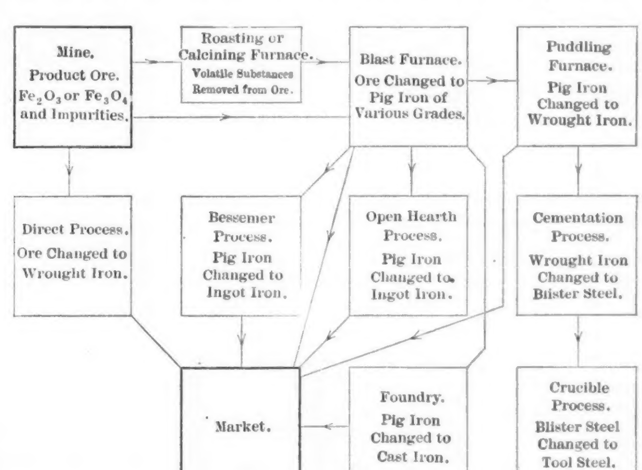
METALLURGY OF IRON—RAILWAY CROSSING PLANERS—GASOLINE HOISTING ENGINE—REPAIRING AUTOMOBILE TIRES.

Alloys that melt at temperatures considerably less than that of boiling water, are found very useful for some purposes, especially for taking casts from delicate objects like fabrics, fruits, animal bodies, insects, etc. But it is asserted that all such alloys must contain cadmium if the objects are to be preserved from injury. A German authority states that such an alloy is Woods metal which consists of tin, two parts; lead, four parts; bismuth, seven to eight parts; and cadmium, one to two parts. This alloy melts at 151 to 162 degrees F. Another alloy, known as Lipowitz's metal—consisting of tin, four parts; lead, eight parts; bismuth, fifteen parts; and cadmium, three parts—softens at 121 degrees F. and becomes perfectly liquid at about 151 degrees.

GRAPHICAL ILLUSTRATION OF THE METALLURGY OF IRON.

The diagram herewith illustrates graphically the metallurgy of iron from the mine to the market and affords an interesting means of tracing out the different processes and showing the kind of steel or iron which each process produces.

Thus we see that the ore may by the direct process, be changed at once to wrought iron in which form it is placed upon the market. The ore may go to the direct blast furnace or, if volatile substances are contained in the ore, it is first roasted, by which method these substances are removed and the ore made ready for the blast furnace. In the blast furnace the ore is changed to pig iron of various grades which may be placed directly upon the market or it may be then



Industrial Press, N. Y.

Fig. 1. Chart Illustrating the Metallurgy of Iron.

treated by any one of several processes. If treated by the Bessemer process the pig iron is changed to ingot iron, in which form it is placed upon the market. If treated by the open-hearth process it is also changed to ingot iron. If, however, the pig iron is sent to the foundry it is made into cast iron and placed upon the market in the form of castings. In the puddling furnace the pig iron is changed to marketable wrought iron or it may be treated by the cementation process, in which it is changed to blister steel, from which, by the crucible process, we obtain tool steel.

DUPLEX PLANING MACHINE FOR RAILWAY CROSSINGS

The machine shown in the accompanying illustration was constructed at the Ancoats Works, Manchester, England, and was designed for planing and finishing railway crossings to a point, and at various angles, from rails of heaviest sections after they were put together at the required angles. There are two transverse foundation beds arranged to radiate from fixed centers on the front foundation bed. These beds may be set at the various angles by means of screw and ratchet lever and they are then securely bolted to the transverse beds. Each longitudinal bed is provided with a table to support the rail while it is being planed and is also fitted with a saddle or carriage. These saddles have upright angle brackets cast on the upper face and to these are fitted swivel tool boxes arranged with compound slides, self-acting in the vertical and angular cuts. The horizontal adjustment is by hand and spring clapper. Each saddle is driven independently and fitted with adjustable stops for various lengths of stroke. Each bed is provided with a separate set of driving gears with single belt and tight and loose pulleys, and the arrangement of the gears is such as to give a quick-return motion to the saddle of 3 to 1.

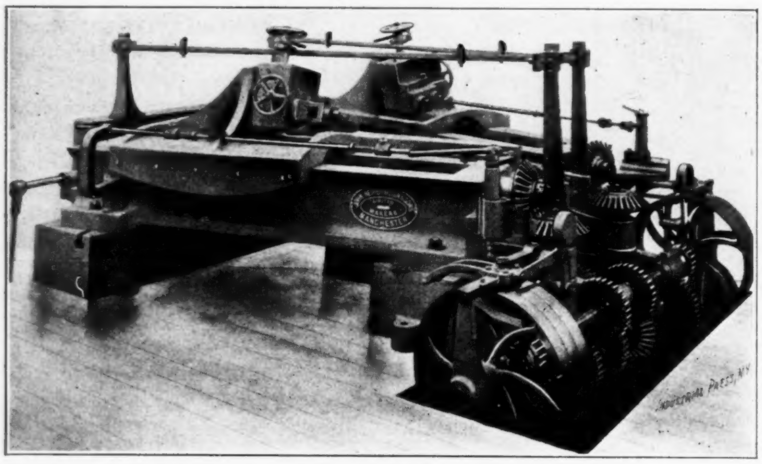


Fig. 2. Duplex Planing Machine for Railway Crossings.

F. C. P.

THE EFFECT OF SUBMERGING COAL.

Considerable attention has been bestowed upon the comparatively recent discovery that coal submerged under sea water does not lose its calorific power so rapidly as when exposed to the air. Indeed, Mr. Macauley, who announced the discovery about one year ago, now states that in some cases there is an actual gain in heat-producing power, but this, as we understand it, does not apply to a unit of weight compared before and after submersion. That is to say, a hundredweight of coal submerged for a certain length of time loses by oxidation very slowly, but it does lose a certain percentage of the softer parts by the process of solution. Thus, the remaining portions may show a gain in calorific power because the proportion of ash and non-combustible matter has been proportionately reduced. This might be an important item in the use of coal for fast steamers, where it is desirable to reduce the actual weight of coal carried to the lowest possible figure, to say nothing of avoiding the loss by oxidation, which is inevitable where coal is stored for some time in the open air, especially in warm weather.

THE USE OF CALCIUM CARBIDE IN SUBMARINE BOATS.

It is generally known that calcium carbide forms acetylene gas rapidly when immersed in water, and, if confined, considerable pressure can be generated in this manner. In the December, 1902, issue mention was made of the suggested use of calcium carbide in a cylinder above a piston for producing heavy pressures, as required for baling cotton, hay, straw, etc. By its use, it was pointed out, such apparatus would be greatly simplified, the pumps and motive power required for a hydraulic press being made unnecessary. This property of calcium carbide has been utilized in Germany in another direction, which also makes the use of pumps unnecessary, and that is for raising and lowering submarine boats. The rapid formation of actylene gas presents a convenient method of increasing or decreasing the displacement of such a vessel as is necessary when it is to be raised or sunk. The boat is supplied with a gas generator. connected to the water reservoirs, which act as ballast. The introduction of a carbide cartridge into the generator produces gas which, admitted by a valve to the water reservoirs, displaces the water and lightens the craft so that it rises; releasing the gas so that the water fills the reservoirs, of course, causes it to sink. The apparatus is simple, compact and requires no pumps.

A GASOLINE HOISTING ENGINE.

One of the latest applications of the gasoline engine is its use for hoisting machinery, as illustrated in Fig. 3, which shows a gasoline hoisting engine of recent design. The motive power is supplied by a horizontal gasoline engine of standard type, having directly connected to the crank shaft, by a single gear reduction, a winch shaft which carries a hoisting drum that is made in various sizes to suit the requirements. This drum is controlled, as in the ordinary steam winch, by a friction clutch and brake under the immediate command of the operator. In raising the load the clutch is thrown in; while in lowering, it is disengaged and the speed of the drum is controlled by the friction brake. The speed of the engine may be varied while in operation, and all levers and regulators are operated from one position.

Upon the outer end of the drum shaft is placed a secondary drum or "nigger head," and the outer end of the crank shaft carries a pulley so that the engine may be used for power purposes if desired. When it is so used the hoisting mechanism is disconnected and stands idle. The gasoline tank and the batteries for operating the sparking mechanism are placed in the base of the engine, so that the whole forms a single unit which can be transported as easily as the ordinary steam winch alone, and the need of boilers and feed tanks is obviated. This winch is built by the Columbus Machine Co., Columbus, Ohio.

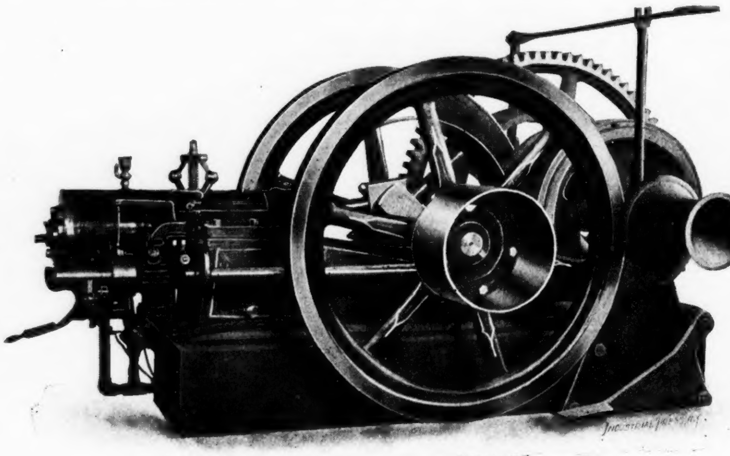


Fig. 3. Gasoline Hoisting Engine.

NEW METHOD OF TIRE REPAIR.

A novel method of repairing automobile inner tube tires has been brought out recently by a European firm of tire makers, which is designed to avoid the troubles incident to the ordinary method of repairing punctures in inner tubes. When patches are applied with cement it appears that they will invariably loosen when run at high speed, and thus cause the deflation of the tire. The only way heretofore to make such a repair reliable has been to vulcanize the patch on the inner tube. The new method makes use of a rubber rivet, *A*, having a hollow stem. This rivet is pushed through the puncture, using a blunt punch for the operation as shown at *B*. After the rivet is in position, a shot such as used in shot-

guns of about the size known as B or BB, is pushed through the stem until it reaches the bottom where, of course, it enlarges the stem to a considerably larger diameter than it is in the neck where compressed by the walls of the punctured tube. For large punctures it may be necessary to use a steel ball

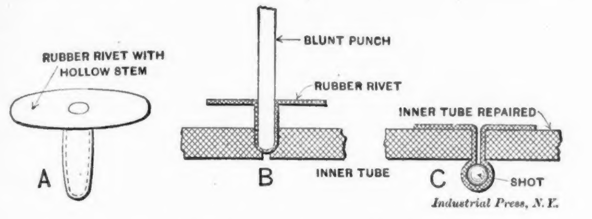


Fig. 4. Repairing an Automobile Tire.

such as used in bicycle bearings. The result is that the rivet cannot become dislocated when in use without tearing off the stem or greatly enlarging the hole. Of course the under side of the rivet head is treated with rubber cement before being placed in position.

* * *

OLD GEAR CUTTER—HISTORY JOHN STEPTOE SHAPER CO.

In the new shop of the John Steptoe Shaper Co., Cincinnati, Ohio, there is an old gear cutter that seems oddly out of place among the other modern machine tools, but is only kept as a relic, its work now being done by a modern automatic machine.

This cutter is of the type built along in the forties and fifties by the Putnam Machine Co., of Fitchburg, Mass., but whether they were the makers of this particular machine is not evident since there is no maker's name on it. The index plate is fixed upon the vertical work spindle on which were mounted the blanks to be cut, which might be both spur and bevel, since the machine was originally adapted for both. The index plate is about three feet in diameter and contains fully 18,000 holes, all of which were probably laid out, and drilled without the aid of a jig. The outer row contains 500 holes and there are 51 circles in all. The number of holes and the arrangement differ somewhat from the old Putnam gear cutter of the same type illustrated in the October, 1897, issue of MACHINERY. That machine had 468 holes in the outer circle and 52 circles, making a total of 15,690 holes. As stated, the machine is retained as much for its association with the past as any other reason, the John Steptoe Shaper Co. being the oldest machine tool builders west of the Allegheny Mountains. In this connection it may be of general interest to give a short history of the concern which was written at our request:

"The history of the company begins when, in the year 1845 John Steptoe was running a small machine shop in this city, it being at that time the only shop west of the Allegheny Mountains building machine tools. Shortly after starting his shop, Mr. Steptoe took into partnership Mr. McFarland, at the time a patternmaker, and formed the firm of Steptoe, McFarland & Co., and manufactured machines of every description. At first the firm employed but three men, but the business steadily increased and, in 1860, Mr. Nottingham, a foundryman, was admitted to partnership, and Steptoe, McFarland & Co. increased their force and established their own foundry. It would not be out of place here to say that The John Steptoe Shaper Co. still have calls for repair parts for machines built at this time, which means that these machines are still considered worth repairing after forty or fifty years of service. In 1870 the partnership was dissolved and, as the demand for shapers was steadily increasing, Mr. Steptoe, operating under the name of John Steptoe & Co., went into the manufacture of this style of tool exclusively, and produced about fifty machines the first year.

"The business was carried on as above until February 25, 1888, when John Steptoe died. At his death the business came into the hands of George Oetting and Adam Lauther, who had been associated with Mr. Steptoe for some years previous. These parties carried on the business under the same name and on the same lines at the old place, until in the fall of 1902, they found their quarters too small for the steadily increasing business and erected a modern two-story factory on Colerain Ave., in the heart of the machine tool district of Cincinnati

"On January 1, 1903, the business was incorporated as The John Steptoe Shaper Company and continued the manufacture of shapers exclusively; the management being in the hands of George Oetting as president, and Adam Lauther as secretary and treasurer, and a board of directors. This continued until August, 1903, when Messrs. Oetting and Lauther decided to retire from active participation in the business and disposed of a part of their interests to Messrs. A. L. Rich and O. H. Broxterman of The A. L. Rich Company, and Mr. Alexander Dom, formerly superintendent of the metal department of the Globe-Wernicke Co. for many years. These gentlemen took over the active management with Mr. Dom as president and Mr. Broxterman as secretary and treasurer, and the output to-day is from 500 to 600 shapers annually, ranging from 14 inches to 34 inches stroke. Each machine is manufactured from a complete set of jigs and templates and this system of manufacture, established by many years of experience has led to the training of specialists who produce a maximum amount of work in a minimum amount of time."

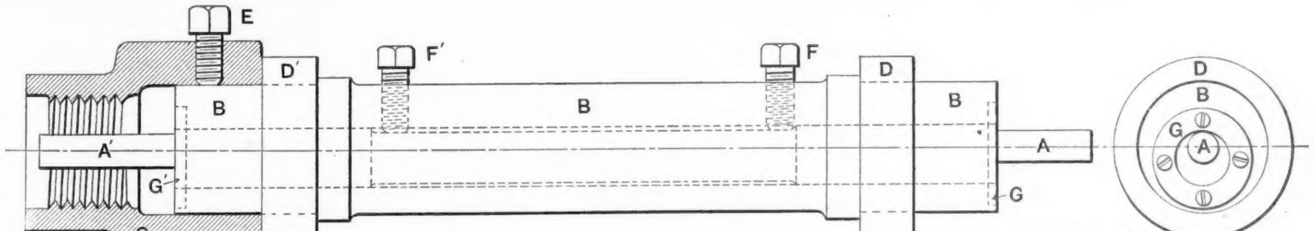
We may add that this concern having been in the machine tool business so long, might naturally be thought to have had an important influence on that industry in Cincinnati, and such is the case. Many of the members of the machine tool concerns in that city worked at Steptoe's and some served their apprenticeships there. In an old-time book still in the office of the company may be found the following prominent names: Mr. William Lodge, of the Lodge & Shipley Machine Tool Co.; Messrs. A. L. Smith and James Mills, of Smith & Mills; Messrs. Ed. Gang, William Barker, Thomas Chard, William Oesterlein and others whose product is well known wherever machine tools are used. Mr. Mills was Steptoe's foreman for over twenty years before going into business for himself.

* * *

CONTRIBUTED NOTES AND SHOP KINKS.

JIG FOR TURNING BACK GEAR SHAFTS.

C. A. Shafer sends a sketch of a fixture that is used for turning the eccentric ends of back gear shafts. These shafts are first turned and ground straight and are then placed in the fixture for turning the ends *AA'*. *B* represents the jig proper and *C* is a chuck, screwed onto the nose of the spindle, by which the jig is driven. *DD'* are hardened tool steel collars pressed onto the ends of the jig and ground to run in the steady rest. The setscrews, *FF'* hold the shaft in the jig and the screw *E* holds the jig in the chuck.

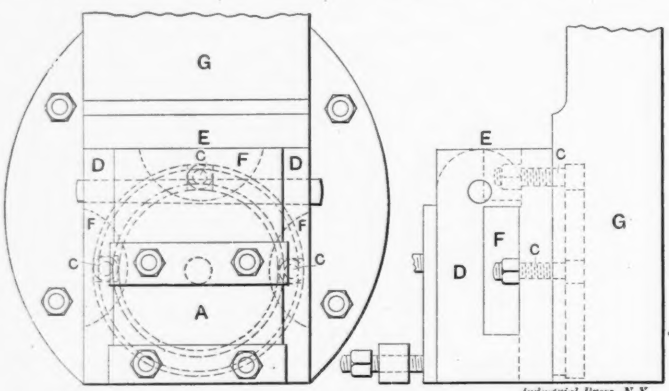


In use the shaft is placed in the jig as shown, the collar *D* being supported in the steady rest, and the end *A* is turned to the required size, the eccentricity of the jig causing it to be turned eccentric with the main portion of the shaft. The entire jig with shaft in place is then removed from the chuck and turned end for end so that the collar *D'* runs in the steady rest, and the end *A'* is turned in the same manner as *A*.

GG' are tool steel washers inserted in the ends of the jig for the purpose of forming length gages. The end view shows the relatively eccentric positions of the different parts of the jig.

AN IMPROVED FORM OF PLANER APRON.

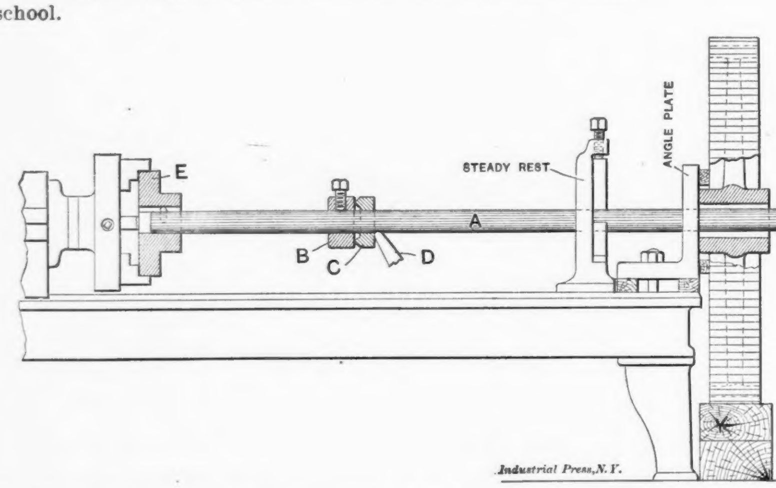
A. D. K. sends a sketch illustrating a form of planer apron which he has found to have considerable advantage over that which is ordinarily furnished. This form is in use by the company with which he is connected and has been furnished, to their specifications, by several of the leading manufacturers of planers. The apron box *D* is cut straight at *E*, doing away with the usual fan-shaped piece with two screws to hold the box in position. On the three sides *F F F* are slots large enough for permitting a wrench to grip the nuts of the bolts



C C C which travel in a circular T-slot cut in the head *G*. The block *A* is hinged in the box *D* in the usual manner. This style of apron is very stiff and can be swung completely around, which will be found very handy when cutting angles of over 45 degrees and also for jobs of undercutting, such as the guides on the under side of a lathe bed, which can be done without any special fixtures or tools.

BORING A 42-INCH GEAR ON A 16-INCH LATHE.

A. Putnam sends a sketch of the method by which he was able to bore out the hub of a 42-inch cast gear when the largest machine available was a 16-inch engine lathe. This is a sample of the kind of jobs that are sometimes encountered in remote districts—in this case a Western mining locality—and is a good illustration of the ways and means that some of our ingenious mechanics have to scheme to perform work that would completely phase a machinist of the modern school.

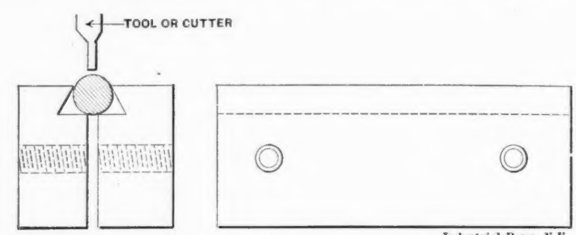


The casting was bolted to the end of the lathe by means of an angle plate so that its center would be on a line with the center of the lathe, the weight of the casting being borne by means of blocking on the shop floor. The boring bar, *A*, was supported in the steady rest as near to the gear as the angle plate would allow, and as the cuts were light the spring of the bar was not sufficient to prevent obtaining satisfactory results. In the faceplate chuck was placed a shaft coupling, *E*, that chanced to be at hand, bored to the same diameter as the bar, which was a piece of cold-rolled shafting. In the end of this bar was driven a hardened pin which fitted a keyway in the coupling and thus furnished a drive for the bar. In the other end of the bar a boring tool was inserted in the usual manner.

A collar *B* was firmly fastened on to the bar at about the center of its length and against this bore a loose collar, *C*, having its edge turned down to reduce the friction. Against this second collar was placed a round pointed piece of steel, *D*, which was carried in the tool post, so that as the carriage was fed along by the regular lathe feed the boring bar was fed through the gear casting.

SPECIAL VISE JAWS FOR PLANING KEYWAYS.

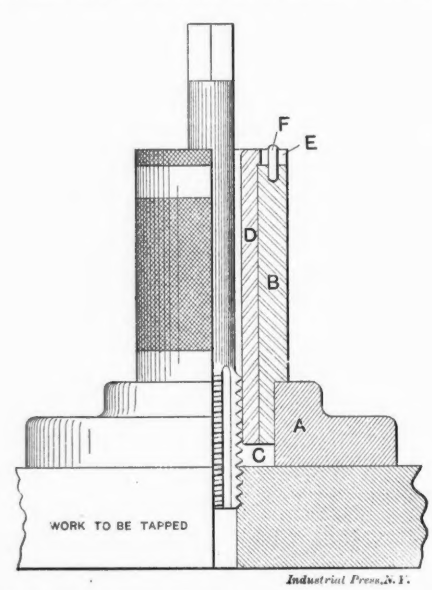
The accompanying sketch, contributed by "A. P.," shows a pair of special vise jaws for use on the shaper or milling machine for holding small, round stock so that it will lie parallel with the vise when planing or milling keyways. The



sides of the dovetail should make an angle of about 60 degrees with the bottom, and the thickness and height of the jaws will be regulated by the vise with which they are to be used.

A TAPPING JIG.

R. A. Lachmann contributes a sketch and description of a combination jig and bushing for tapping holes perfectly true without the necessity of using a square for starting the tap. This jig consists of a base, *A*, made of mild steel or cast iron, the bottom being of any shape that is suited for use on the pieces that are to be tapped. Into this base is fitted the standard, *B*, leaving a clearance space between its end and the face of the base, as at *C*, in order to allow space for burrs thrown out by the tap. Fitting this standard are a set of bushings, *D*, made of suitable sizes for guiding the different sizes of drills that are to be used. These are a good sliding fit in the standard and are all slotted at *E* so as to fit over a



small pin, *F*, which prevents them from turning when in use. Any number of bushings may be made for use with a single base, but two or more bases, one for large and one for small sizes, should be provided so as to be better suited to the size of the work. If this jig is held down firmly onto the face of the work it will insure the tap starting straight, and when it is once started the jig may be removed. This arrangement makes it possible to tap holes perfectly straight with but little care and also prevents breakage of taps, especially when using the smaller sizes.

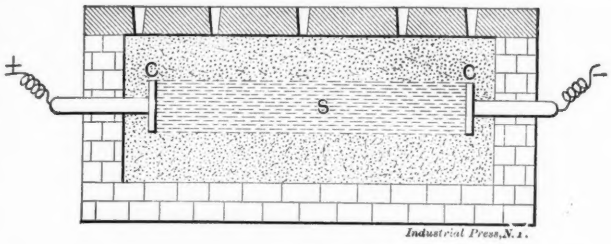
HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

10. A. H. L.: Will you please explain the construction and use of electrical furnaces?

A. An electric furnace, as the name implies, is one in which the heat is produced by the electric current. The general principle involves the formation of an arc between carbon electrodes, and the substance to be treated is exposed to the heat thus produced. Electrical furnaces are used mainly for metallurgical purposes such as the reduction of aluminum and silicon. The sketch shows, diagrammatically,



the general arrangement of electrical furnaces which are, of course, more or less modified to suit the conditions. The space in which the reduction takes place is that between the carbon plates, *C C*, which are connected to the electric terminals as shown. In this space is placed the substance to be treated, *S*, while the space above, below and around the sides is packed with powdered carbon or other non-conducting substance. The walls are of fire brick and the cover of fire clay provided with vent holes.

11. G. A. H.—Kindly tell a reader of MACHINERY how to drill holes in glass.

A.—You do not state what size holes you desire to drill. The best method for drilling holes of medium size is by means of the sand blast and for small holes by the use of a black diamond drill. The black diamond can also be employed for large holes, if several cutting points be inserted in the end of a tube, the tube used as a trepan. As neither of these methods may be convenient for you to adopt, you may have to resort to the old plan of using a very hard drill, lubricated with turpentine. When the drill is about to break through the glass, turn the glass over and drill through from the other side, meeting the first hole. Or if it is not convenient to turn the glass over, clamp a piece of cast iron against the glass, where the hole is to come through, and drill through the glass into the iron. If the iron fits the glass closely the drill will not chip the edge of the hole to any extent in breaking through. It is a good plan to put a sheet of paper between the iron and glass, as this will tend to compensate for any irregularities in the surface of the glass and make better contact with the iron. For holes of medium size you can use a brass or copper tube for drilling, with some abrasive like carborundum or emery to do the cutting. Guide the tube by means of a bushing, so it will run true and stand square with the face of the glass, and rotate the tube at high speed. Allow the abrasive to work under the edge of the tube, and lubricate with water.

12. S. H. S. asks for information regarding the components of the different brands of self-hardening steels and also for an explanation of the Harvey and Krupp processes for hardening steel plate.

A.—1. Most of the self-hardening and high-speed steels are composed of practically the same components, but the percentages of each, and the manner in which they are combined, form trade secrets, which are carefully guarded by the manufacturers. In "Iron, Steel and other Alloys," by Henry M. Howe, the composition of the good self-hardening steels of the present time is given as between the following limits:

Carbon	0.40	to	2.19	per cent.
Chromium	0.00	to	6.00	per cent.
Tungsten	3.44	to	24.00	per cent.
Silicon	0.21	to	3.00	per cent.

The present tendency appears in the direction of replacing the chromium, of steels for high-speed cutting tools, with from 1.25 to 4 per cent. of manganese. 2. Regarding the two processes of hardening plate we quote from the same work: Much of the heavy armor in use is made of nickel steel initially containing so little carbon that it cannot be hardened and remains very ductile even after cooling. The face of these plates is given the intense hardness necessary by being converted into high-carbon steel and then hardened by sudden cooling. Harvey carburized the impact face to a depth of about an inch by heating the plate for about a week to a temperature of 1,200 degrees C. (2,192 degrees F.) with that face strongly pressed against a bed of charcoal. The Krupp process carburizes the impact face by exposing it to illuminating gas at a high temperature. This is decomposed by the heat and deposits on the face of the plate a layer of fine carbon which is absorbed by the steel, as in the cementation process. In either case the face thus carburized is cooled suddenly from a red heat by spraying with iced brine. An intensely hard surface results, decreasing gradually from the face inwards.

13. A. H. G. writes: I desire to make a special study of power and its application, with a view of some day operating and owning power plants. Would it be a good plan to work where I could study and get well enough acquainted with steam engines, their construction, etc., to obtain an engineer's license, and thus get into some power plant? What do you advise as the best course to pursue, both practically and educationally?

A. It is difficult to advise you without knowing what your experience (if any) has been as a machinist, what your technical education has been, and how many years you feel that you can devote to preparation. On general principles, about the best preparation can be obtained in an engine building shop, provided a man is fortunate enough to secure work on the erecting floor and later is able to go out to assist or superintend the erection of engines. If this is not feasible, the next best course to pursue is to at once secure work in an engine room. In any case one should secure all the technical education possible, either by evening or day study; and if you can afford time it would, of course, be desirable to take at least a two-years' technical course at some good school before starting in with the machine shop or engine room experience. A number of schools have good two-year courses that would familiarize one with the various types of steam engines and the principles of steam and its use. There are a great many good books on steam and the steam engine and many which are not good. For elementary works we can recommend Low's "Power Catechism," price $2.00; Ripper's "Steam," price $1.00; Peabody's "Steam Engine Indicator," $1.50; Spangler, Green & Marshall's "Elements of Steam Engineering," $3.00. For more advanced books, Jamieson's work on the steam engine, price $2.50; Meyer's "Steam Power Plants," $2.00; Peabody & Miller's "Steam Boilers," $4.00. You should also study books on electricity, and we can recommend the following: Swoop's "Lessons in Practical Electricity," $2.00, and Rosenberg's "Electrical Engineering," $1.50, which are excellent elementary works. For advanced books on this subject, Selden's "Dynamo-Electric Machinery," price $2.50, which takes up direct-current; and Selden & Mason's "Alternating-Current Machines," price $2.50.

The Lorenz globoid worm gear, made in Berlin, Germany, is attracting some attention in Europe because of its good efficiency and wearing qualities. From the meager description at hand it appears to be a modification of the Hindley hour-glass type, or perhaps an improvement of same in the matter of manufacture. In the making of the globoid worm gear proper, the worm is first cut by means of a cutting tool swinging in a circle, while the worm also turns about its axis. Lorenz has inverted this process and first forms the wheel teeth with a simple cutting tool, afterward cutting the worm so as to fit the wheel teeth as closely as possible.

* * *

In the August issue of MACHINERY the address of Reinecker Bros., builders of the German worm-milling machine there illustrated, was wrongly given as Coblenz, Germany. It should have been given Gablenz, which is a suburb of Chemnitz, Saxony.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

OESTERLEIN UNIVERSAL DIVIDING HEAD.

Figs. 1 and 2 illustrate a new universal dividing head, for standard and differential indexing, that has just been placed on the market by the Oesterlein Machine Co., Cincinnati, Ohio. This head is arranged to make all divisions from 1 to 380, with the spindle in any position from horizontal to vertical. The differential indexing is obtained by connecting the index plate *A* and rotating it, in a certain ratio, with the crankshaft *B*. This shaft is connected to the spindle by worm

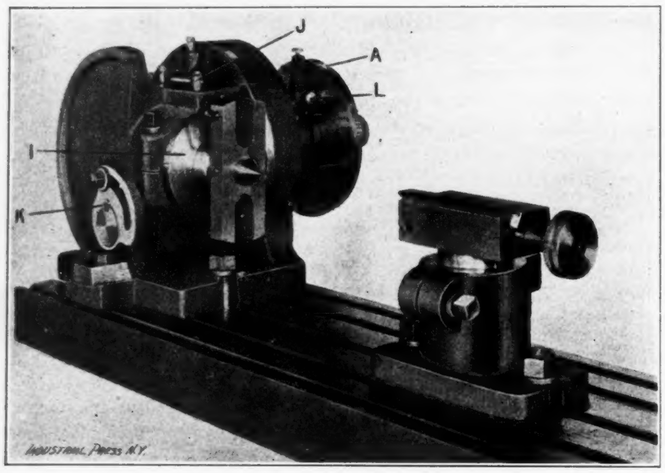


Fig. 1. Oesterlein Universal Dividing Head.

gearing and consequently both spindle and index plate revolve in the same or opposite directions in accordance with the divisions that are to be obtained. The principle of differential indexing has recently been thoroughly explained in these columns and its application to this particular head is illustrated in Fig. 2, which shows the arrangement of gearing when set for making 107 divisions.

The swivel head is fitted into the frame with taper shank and is held in position by the clamping plate *C* and nuts. For quick spacing a dividing plate *I*, having 24 divisions, is fitted to the front of the spindle, the index pin is operated

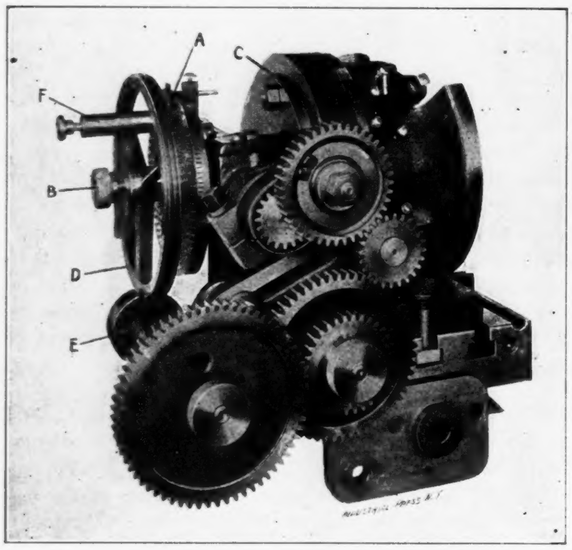


Fig. 2. Oesterlein Dividing Head set for 107 Divisions.

by the crank *J*, and the whole is enclosed and protected from dirt. When this is in use the worm is disengaged from the spindle by means of an eccentric bushing *K* which can be re-engaged by pushing against a stop without adjusting. The crankshaft *B* has secured to its outer part a worm *D* which engages a worm wheel on a shaft running in the bracket *E*. The index plate *A* rides loose on the crankshaft and is connected by proper gearing, for spiral cutting with the table screw and for differential indexing with the wormwheel spindle. The index plate is graduated on its face for the purpose of setting the sector to the desired position by degrees in place of counting the number of holes, a table being furnished for this purpose. For standard indexing requiring delicate adjustment of the spindle, the index plate can be rotated by means of the thumbscrew *L*, placed back of the plate. When the head is used for standard dividing, the bracket *E* may be readily removed. The front end of the spindle is threaded and has a taper hole corresponding to that of the machine spindle. The head swings 11 inches and can be locked without throwing it out of adjustment. The tailstock has a vertical adjustment of 2 inches.

SPECIAL AUTOMATIC MILLING MACHINE.

The half-tone, Fig. 1, illustrates a very interesting machine built by the Newton Machine Tool Works, Philadelphia, Pa., which is a new departure in the milling machine line and is designed to adapt itself to a very peculiar operation. In the work to be milled the cut is very light at the start but increases gradually until near the finish and when the end is

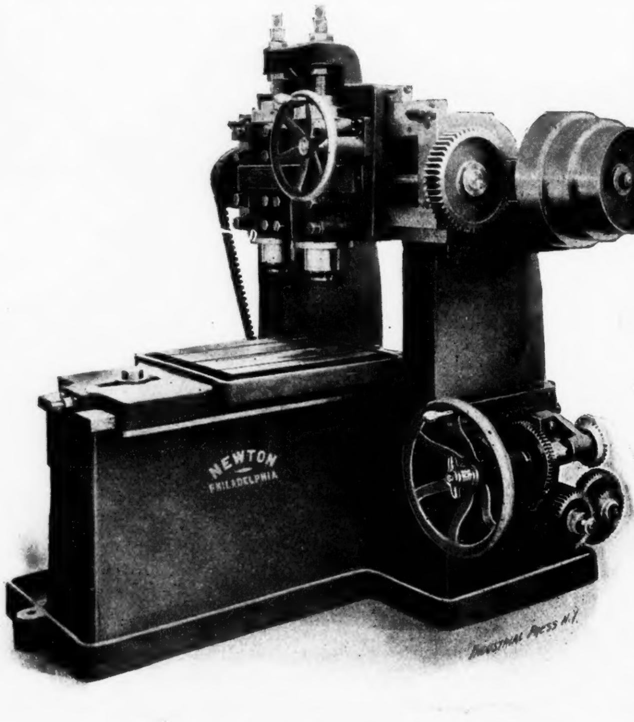


Fig. 1. Newton Special Automatic Milling Machine.

reached the cut is very heavy. The machine is also required to stop its feed at an exact point. The milling cutters used on the work are about 6 inches in diameter, and when they reach the finish about one-half of the cutter is in the cut.

The difficulties of making any automatic trip stop that will operate at an exact point will be readily appreciated, and it is quite a complication of feeds that would be required to produce the result desired, that is starting off with a fast feed and gradually reducing until finally coming to a dead stop at the finish. So the machine was designed to employ a crank feed by which the required results are very satisfactorily accomplished.

Primarily this machine is a heavy vertical spindle miller having two spindles, both of which are mounted on one saddle and have an adjustment vertically for convenience in setting to the work. The ends of the spindles are threaded so that cutters can be fitted to the nose, but only one spindle is in operation at a time, as one is used for the roughing cutter and one for the finishing. When the head is over against one of the stops the roughing cutter is in the center, and when the roughing cut is completed, the saddle, carrying both spindles, is moved across the rail by hand wheel to the other stop, which brings the finishing cutter in exactly the same position.

The feed of the machine, which is more clearly illustrated in the drawing, Fig. 2, is through a silent chain drive and two sets of gearing with a shove pin to give a quick change of feed from the roughing to the finishing cut. Driven through a train of gearing is a large wormwheel which acts as a crank, carrying the connecting rod which is coupled to a crosshead on the front of the carriage, this crosshead having a screw on the front end, for convenience in adjusting carriage and connecting rod. It will be seen that this feed must necessarily be at its fastest when the crankplate is on one quarter of a turn, (the position shown in the drawing) and this will gradually decrease until it gets to the turning point when it starts to reverse, thus producing the result which is necessary on the work. The length of feed is varied by shifting the crankpin across the face of the crankplate, a screw and nut connection being provided for this purpose. As the material to be milled is steel the entire machine is set in a pan to provide for the heavy lubrication that is necessary on this work.

FELLOWS GEAR SHAPER WITH ELECTRIC MOTOR DRIVE.

The accompanying photograph illustrates the Fellows gear shaper as it has recently been arranged for individual motor drive. The only change necessary was the casting of a plate to span the pillow blocks of the regular driving gear to afford a support for the motor, and the substitution of a sprocket wheel for the cone pulley used with belt drive. With these alterations a standard form has been evolved as shown in the illustration. A 5 horse power, semi-inclosed type motor manufactured by the Crocker-Wheeler Co., Ampere, N. J., supplies the power, transmitting it, with a reduction in speed, through a Renold silent chain to the spindle which normally holds the cone-pulley. The speed is further reduced through either of the two regular gear combinations which are used alternately, making two speeds possible mechanically. In addition the motor is supplied with current on the Crocker-Wheeler four-wire multiple voltage system giving it six independent speeds, and with the use of resistance twelve intermediate ones. The upper ten of the motor's eighteen speeds constitute its working range, within which, through the faster gear combination it drives the ram at from 45 to 94 strokes per minute, or with the slower gear combination, 20 to 43. The lower eight available motor speeds may be used to extend the range down to six strokes per minute, though 20 is the minimum in ordinary practice. The machine is capable of cutting external gears up to 36 inches in pitch diameter by 5 inches face and internal gears 28 inches in pitch diameter by 3 inches face, allowing any diametral pitch up to four.

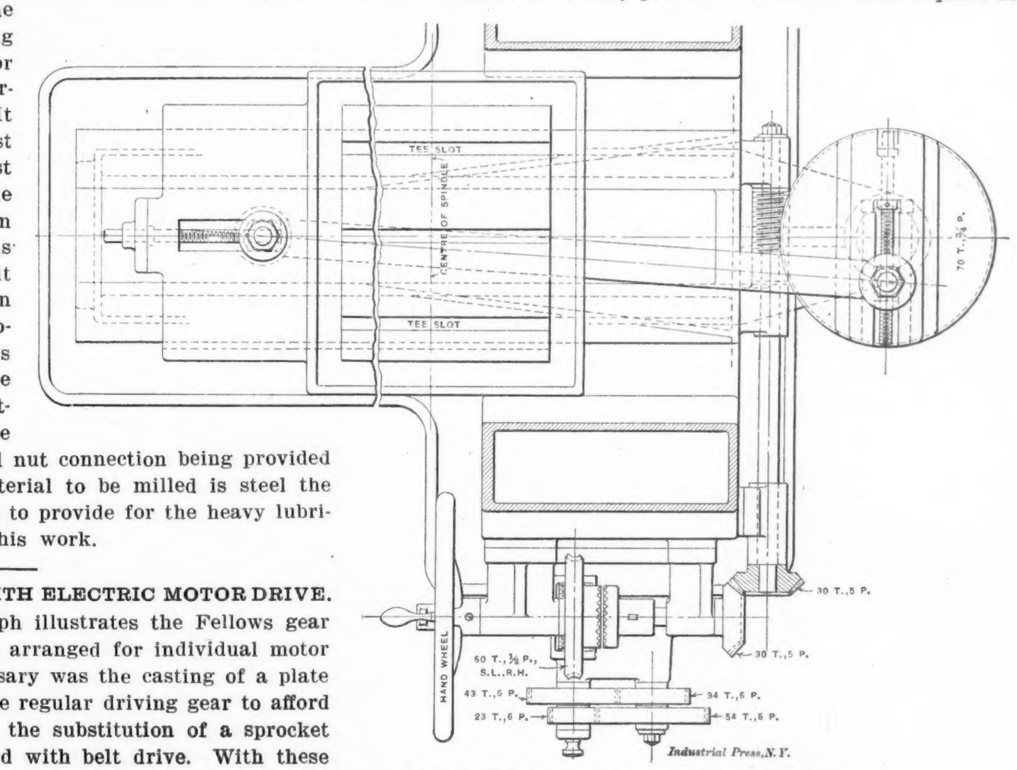
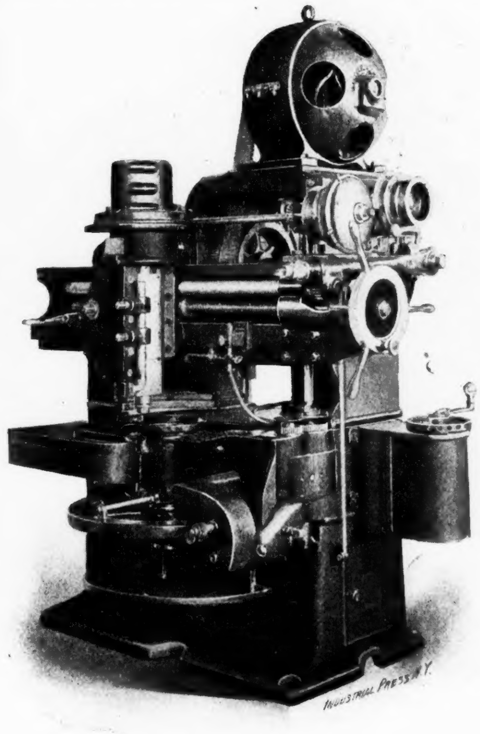


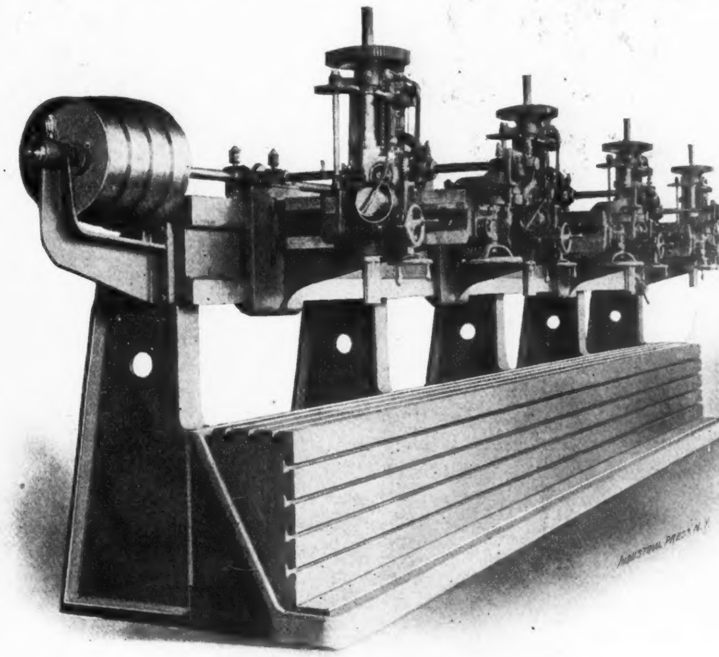
Fig. 2. Detail of Feed for Special Automatic Milling Machine.



Fellows Gear Shaper with Motor Drive.

LOCOMOTIVE FRAME DRILL.

The four-spindle drill shown in the accompanying halftone has been designed and built by the Bickford Drill & Tool Co., Cincinnati, Ohio, from specifications submitted by the Locomotive and Machine Co., Montreal, Canada. This machine is used for drilling, reaming and tapping the sides and edges of locomotives frames up to 27 feet 3 inches between holes.

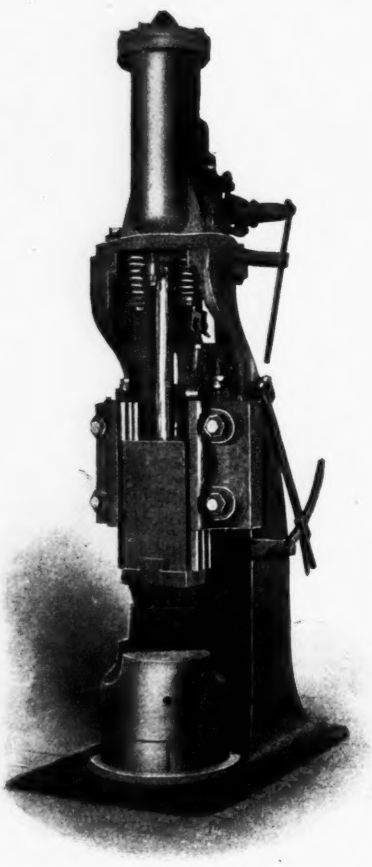


Four-spindle Locomotive Frame Drill.

The arms are made in pipe section and are adjustable on the rail by either hand or power. One of these is made to ro-

tate through an angle of 30 degrees. The spindles have eight changes of speed ranging in geometrical progression from 49 to 120 revolutions per minute and are provided with both hand and power feed, quick advance and return, safety stop, automatic trip, dial depth gage, and hand lever reverse. The back gears are located on the head, bringing the power directly to the work and may be engaged, disengaged, or thrown out of service while the machine is running, the operator not having to reach the shifter in order to stop the spindle.

The depth gage answers a double purpose since, in addition to its use by the operator for reading all depths from zero—thus obviating the necessity of scaling or calipering—it supplies a convenient means for setting the automatic trip, the graduations showing exactly where each dog should be set in order to disengage the feed at the desired points. The automatic trip operates at as many different points as there are depths to be drilled at one setting of the work and in addition it leaves the spindle free, after any intermediate tripping to be advanced, raised, or traversed its full length without disturbing the setting of the dogs. It also throws out the feed when the spindle reaches its limit of movement.



Eight Hundred pound Double-acting Steam Hammer.

The feeding mechanism furnishes eight rates of feed ranging in geometrical progression from .007 to .064 inch per revolution of the spindle, all of which are instantly available without shifting a belt or operating under a feed of unnecessary fineness. The tapping mechanisms are located on the head and are fitted with friction clutches operated by levers the handles of which extend around under the arms within convenient reach of the operator. The spindles have a vertical adjustment of 17 inches and operate over an area of 2 feet 4 inches wide by 27 feet 3 inches long. The table has a width of 18 inches and is 29 feet in length. This machine weighs 49,000 pounds and is driven by a 5-inch high-speed double belt.

EIGHT HUNDRED POUND DOUBLE-ACTING STEAM HAMMER.

The new double-acting steam hammer which is illustrated herewith has recently been placed upon the market by the Bethlehem Foundry & Machine Co., South Bethlehem, Pa. The piston rod and head of this hammer are made from one solid steel forging and the ram is a steel casting, running on V-shaped guides which are adjusted for wear. The piston head can be raised above the top of the cylinder without removing the rod from the ram, permitting an examination or replacing of the rings. The piston is steam cushioned on top to prevent it from striking the cylinder head. The valve motion is automatic and of simple construction, employing a balanced valve of the piston type which moves very easily. It is controlled by a single hand lever by means of which the operator can strike single blows of any desired force from the lightest to the full capacity of the hammer, or cause the hammer to strike a succession of blows automatically. The steam supply is controlled by a balanced throttle valve by means of a hand lever. The steam cylinder of this hammer is 8¼ inches in diameter and the stroke 24 inches. The falling parts alone weigh 800 pounds while the weight of the hammer complete is 14,000 pounds.

BULLARD BORING AND TURNING MILL.

Fig. 1 of the accompanying illustrations shows a new form of boring and turning mill that has just been brought out by the Bullard Machine Tool Co., Bridgeport, Conn. This

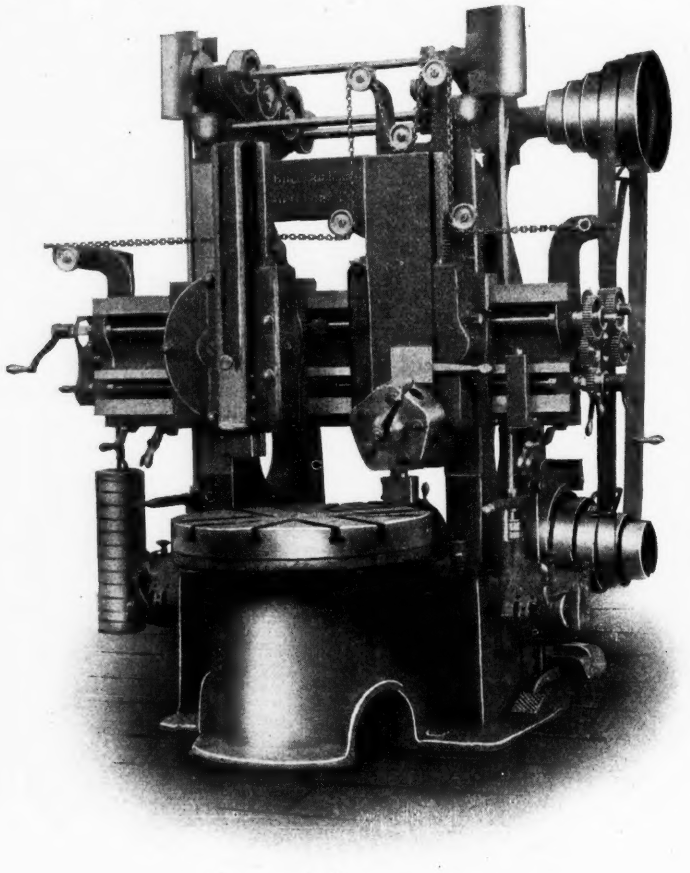


Fig. 1. Bullard 42-inch Boring and Turning Mill.

machine regularly has one fixed turret head and one swivel head, although two swivel heads can be supplied if required. The machine is driven from the side so as to permit the application of a constant or variable speed motor at any time that it may be desirable. The cross rail heads are operated by power, which is obtained by driving the vertical feed rods at a high constant speed from the overhead shaft, and at a variable speed through an independent feed box on the bed at the lower end of the rods. A lever which is movable in both directions from its normal position, operates a clutch mechanism in the bevel gears of the overhead bracket, giving the vertical rods a movement in either direction as desired, and driving the cross rail heads through the regular feed brackets on the back of the rail. When this lever is in its normal position the overhead clutches are disengaged and the feed works of the lower brackets are automatically engaged with the vertical rods. This makes it impossible for the quick traverse to become engaged at the same time as the feed works, and obviates the necessity for the operator to disengage the feed works before operating the quick traverse.

The feeds are positive, having ten changes ranging from

1-32 to ¾ inch horizontally, and from 1-50 to ½ inch in angular and vertical directions. In the cross rail bracket on each head the feed is engaged and disengaged by a toggle friction, operated by a hand lever, which not only provides a quick means of engaging and disengaging the feed but also answers for a safety device to prevent accidents in case of the heads being run together, either by the quick traverse or by the feed mechanisms. The right-hand head is provided with screw cutting gears that are entirely independent of the feed gears, so that it is possible to bore out a hole with as fine feed as required and then, without changing any gears, immediately chase the hole with any thread for which the machine is geared. The turret head is arranged to cut all standard threads from 2½ to 12 per inch.

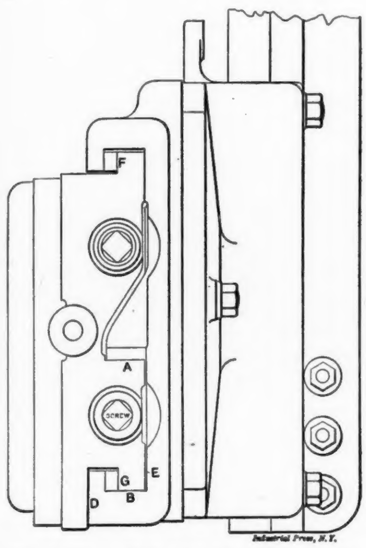


Fig. 2. Cross Rail of Bullard Boring Mill.

The design of the cross rail, shown in Fig. 2, shows the method employed for maintaining the alignment regardless of the severity of the duty required of the machine. The length of the bearing surfaces on the rail has been increased and the width narrowed, the horizontal alignment being obtained on surfaces *A* and *B* with the screw located as near central as possible. The saddle is gibbed back against the rail, receiving its thrust on the surface *D*, and does not bear on the surface *E* but is gibbed between surfaces *F* and *G*. It is of the square-locked type having no loose joints, taper steel gibs being used for taking up the adjustment. This same type of bearing is also employed for maintaining the alignment of the cross rail with the right hand upright, the left hand upright merely acting as a support.

The belt shifter enables the operator to shift the belt from one step to another without injuring his hands even when the machine is running at full speed. A foot brake is applied directly to the large step of the lower cone pulley and brings the table to a stop at any desired point. The counterweighting of the head is accomplished by passing the chain back of the center, where it will be out of the way of any tackle that is used for loading work on the table, and as the turret tools are likely to vary considerably in weight, small weights are employed for increasing or decreasing the counterweight.

The table spindle is of the regular type, the vertical thrust being taken on the angular bearing, which is 24 inches in diameter, and is entirely immersed in oil. The table has parallel slots for the reception of the Bullard spiral jaw chuck but a combination chuck can be fitted if required. The total weight of this machine is 14,300 pounds net.

SPRINGFIELD AXLE BORING LATHE.

Owing to the ever present liability of steel forgings to contain concealed flaws or "pipes" the plan has been adopted by the Pennsylvania Railroad of boring a two-inch hole completely through the center of all locomotive axles, thus affording a means of examination whereby any existing flaws may be detected. Such practice will be seen to present a considerable problem in deep hole drilling, as it must of necessity be accomplished in the least possible time. For this purpose, as well as for general bar and spindle boring, the Springfield Machine Tool Co., Springfield, Ohio, have designed and built the boring lathe illustrated in the half-tone herewith.

This machine has a capacity for boring holes from 1 to 4 inches in diameter, in bars up to 11 inches in diameter, and of any length up to 84 inches. The spindle is a large cast-iron shell having a three-jaw universal scroll chuck secured to a flange that is cast integral with the spindle. This construction will be clearly seen by reference to Fig. 2, which is a partial section through the spindle and driving cone. The bar to be bored is held in the chuck and, passing through the spindle, is supported at the other end by adjustable screws furnished for the purpose. The driving cone is mounted on an auxiliary shaft, placed above the spindle, to which it is connected by means of a pinion which engages with a gear cut into rear flange of chuck. Back gears are provided which, in connection with two speeds obtained from the countershaft, give sixteen boring speeds arranged in geometrical progression.

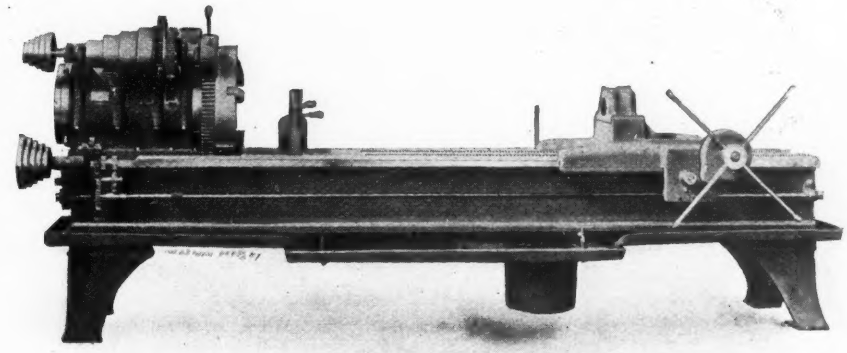


Fig. 1. Springfield Axle Boring Lathe.

A long carriage, which supports the drill and boring tool, slides on large V-s and is gibbed its full length to the outside of the bed. Two racks are provided, one on each side of the top of the bed, into which the pinions mesh, so that the feed is more steady than it would be if but a single rack and pinion, on one side of the bed, were used. The carriage may be rapidly moved into any position by the pilot wheel and the power feed is engaged with a powerful friction. With a five-step cone on the driving shaft, which makes 3¾ revolutions

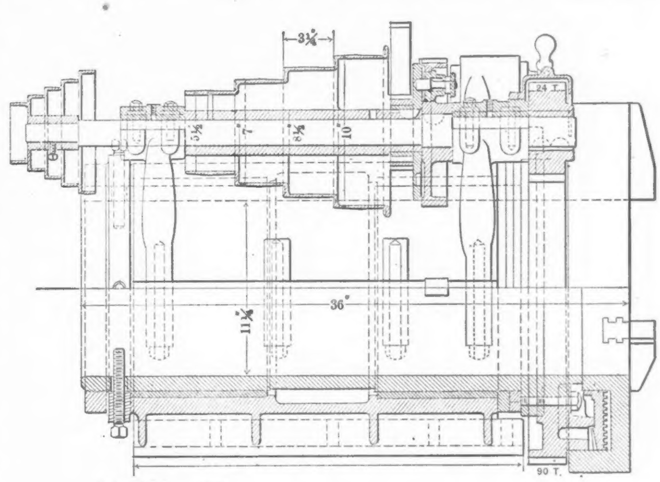


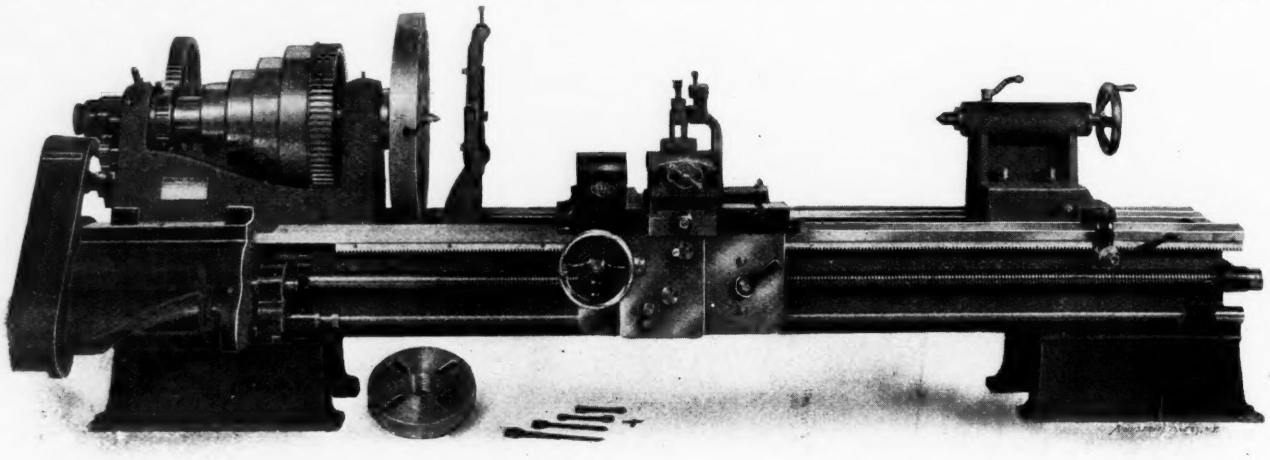
Fig. 2. Section through Head of Axle Boring Lathe.

to one of the spindle, motion is transmitted to a feed cone geared to the feed rod in such manner that two speeds may be obtained from each cone step, thus giving ten rates of feed, ranging from .0005 to .01 inch per revolution of the spindle.

A force pump is supplied for lubricating the cutting edges of the drill and the machine is surrounded with a pan having an oil reservoir of ample capacity so that the lubricant has sufficient time to cool before it is used again. A guide is furnished for centering the tools at the beginning of the hole, but as soon as the hole is started this is swung out of the way.

NEW 32-INCH BANK-GEAR ENGINE LATHE.

The half-tone presented herewith illustrates a new 32-inch lathe just brought out by the Prentice Bros. Co., Worcester, Mass., which embodies several new and improved features of construction as relates to the apron, bank of feed gears and the method of putting on the feed rod and lead screw. As will be seen in the cut, the feed rod and lead screw stop at the end of the gear box. A bank of gears is mounted on a shaft, independent of either the feed rod or the lead screw but so arranged that it may be connected with either by means of a sliding gear, thus making it possible to cut 48 pitches, from ½ to 24, or to give 48 feeds. A tumbler gear connects the shaft, which takes the power from the head end of the lathe to any one of the gears in the cone. The different pitches are obtained by sliding the tumbler along, as indicated on an index plate, giving 12 changes thereby. There are, on the head end of the lathe, four other gears which can be changed and these in combination with the cone, make 48 pitches, there being 38 changes without any repetition. This lathe has a double apron and bevel gear drive and there is a device which obviates any chance whatever for both the feed and screw gearing to become meshed at one time.



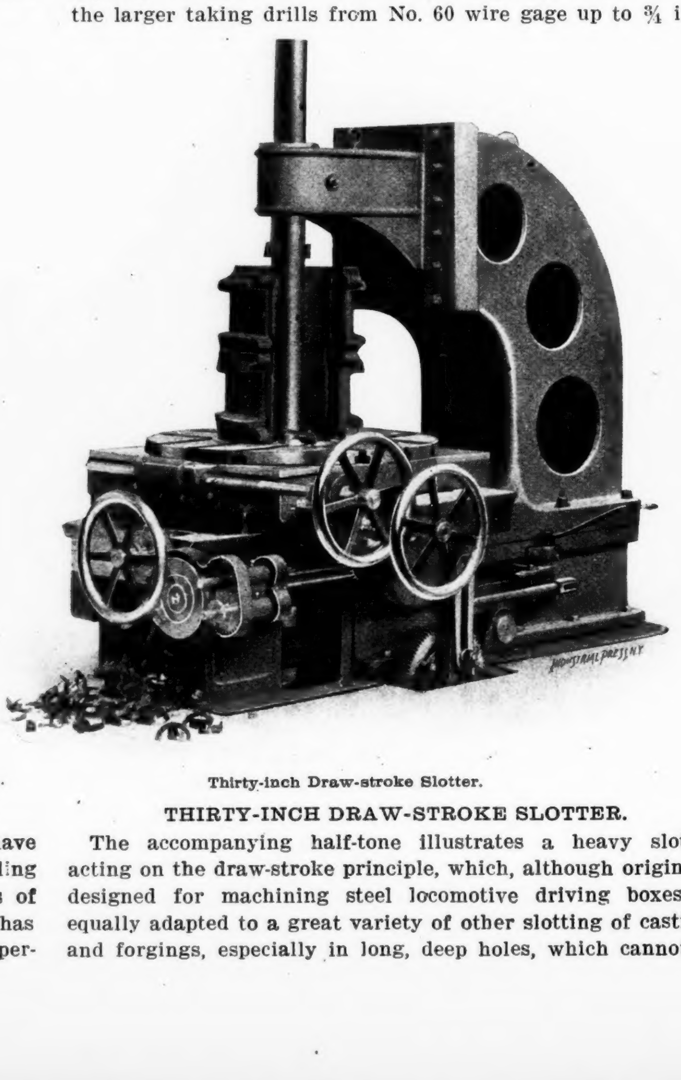
Thirty-two inch Prentice Bank-gear Engine Lathe.

Rotary Platen Multiple Drill.

ROTARY PLATEN AUTOMATIC MULTIPLE DRILL.

The National Automatic Tool Company, Dayton, O., have just placed on the market a new machine for multiple drilling which is designed to meet the demand for a drill press of smaller capacity than their automatic turret drill which has previously been described in these columns. This drill performs practically the same class of work as the turret drill, but has only two clusters of drills instead of six. From four to ten spindles may be used in each cluster, and each spindle is adjustable in any direction. The idea of the double cluster is that one set of drills will drill and the other set may be used to ream or counterbore the same holes, or where two holes are drilled in close proximity, one hole is drilled with the first cluster and the next one with the second cluster.

The feed table, or platen, revolves automatically and may be indexed from two to six times. From three to six jigs may be mounted on the platen, and the operator, standing in front of the machine, simply loads and unloads the jigs as the platen revolves. The operation is thus continuous, two jigs being worked while the others are being loaded. The drills are automatically depressed to meet the work and the machine may be stopped instantly at the will of the operator. The spindles are gear driven, and each drill runs at its own proper cutting speed. The machine is adapted for drilling in steel, cast iron, brass or wood, three changes of feeding speed being provided. It is built in two sizes, the smaller having a capacity for drills from No. 60 wire gage up to ⅜ inch, and the larger taking drills from No. 60 wire gage up to ¾ inch.



Thirty-inch Draw-stroke Slotter.

THIRTY-INCH DRAW-STROKE SLOTTER.

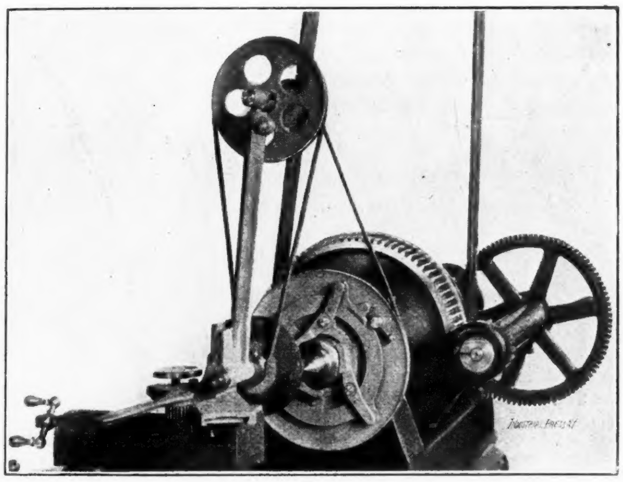
The accompanying half-tone illustrates a heavy slotter, acting on the draw-stroke principle, which, although originally designed for machining steel locomotive driving boxes, is equally adapted to a great variety of other slotting of castings and forgings, especially in long, deep holes, which cannot be

reached by the ordinary type of slotter. It is also adapted to shaper work on the ends of long pieces of such irregular shape that it is impossible to chuck them in a planer, and in addition to these uses, it makes a very handy keyseater. The working table, which is 38½ inches in diameter, is placed low so as to be convenient to the operator. Full automatic feeds in all directions are provided, all of which are readily engaged from the front of the machine, all hand feeds being operated from the same position. The length of feed is adjusted from the right hand side of the machine.

The ram is rack and pinion driven through a heavy train of gearing and is counterbalanced. The reverse is accomplished by shifting belts, which are very wide and shift freely. The bar carrying the cutting tool can be of any shape or size up to 4½ inches in diameter, and one bar may be readily replaced by another by the substitution of suitable bushings. The support of the bar is very rigid, as it is fixed at one end by clamping in a long bearing in the driving ram, is supported by a bushing in the lower table directly below the work, and in a bushing in the upper arm directly above the work. The tool relief on the return stroke is secured by means of a clapper box in the cutter bar. This slotter is the product of Baker Brothers, Toledo, Ohio.

A NEW LATHE CENTER GRINDER.

One of the constant trials of the machinist is the necessity of keeping the lathe centers in good condition, and many styles of grinding attachments have been devised for accomplishing this end. The requirements of any such a device are, that it shall be simple in construction and easily placed in position and that it shall be of suitable mechanical construction to insure smooth grinding at an accurate angle. These conditions seem to have been met in the new center grinder illustrated herewith, which is the product of the Mueller Machine Tool Company, Cincinnati, O.

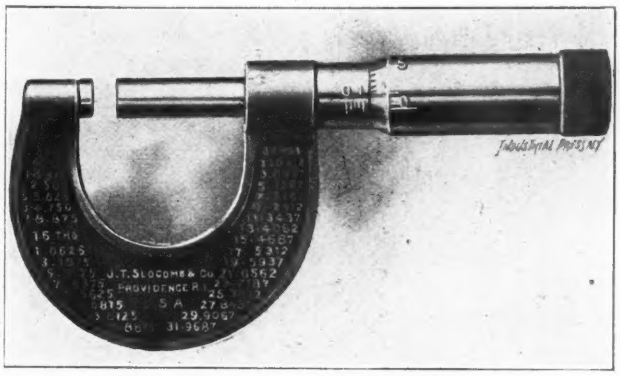


Mueller Lathe Center Grinder.

The pulley by which this attachment is driven is clamped to the nose of the spindle by a universal friction clamp so that marring or scoring of the spindle is entirely avoided. The base of the grinder is bolted to the tool block, its spindle being set parallel with the axis of the lathe by placing it between the lathe centers while setting it in the tool block. The upper part of the attachment slides on the base at an angle of 30 degrees with the axis of the lathe, and this upper part, carrying the wheel, is moved back and forth by a hand lever through the medium of a pinion and rack. The spindle is tapered for adjustment and is driven at about 1,600 revolutions when the lathe spindle is running 250 revolutions per minute. The driving is accomplished by two round belts, provision being made in the intermediate wheel stand for adjusting them to the proper tension. This attachment is also useful for light circular grinding, when it is then operated from an overhead drum. A rest attachment renders it available for sharpening saws, cutters, small drills, etc.

A NEW STYLE OF MICROMETER CALIPER.

The **J. T. Slocomb Company, Providence, R. I.**, have just added to their line of micrometers and shop tools the one-inch micrometer shown in the photograph herewith. This instrument has a polished frame of I-section, and the space within the ribs is utilized for a full table of decimal equivalents—eighths, sixteenths and thirty-seconds appearing upon one side and sixty-fourths upon the other. These figures are raised from the surface by a new process, in a hydraulic press, a pressure of about three hundred tons being required. They



New Style of Slocomb Micrometer.

therefore stand out very clearly, and together with the ribs form a very convenient finger hold as well as bearing the reference table of equivalents where it can be most easily referred to. It has also been noted that the compression of the steel makes the frames very materially stiffer. The other features of the instrument are practically the same as are embodied in the regular line of micrometers manufactured by this company.

A NEW BALL AND SOCKET HANGER.

A shafting hanger of new and novel design has been brought out by the Bantam Mfg. Co., makers of roller and ball bearings, Bantam, Conn. The hangers are planned to accommodate conditions met with in nearly all cases where shafting is employed—namely, shafting out of line, either through the settling of the building or through unequal belt pull tending to deflect the shafting between the hangers.

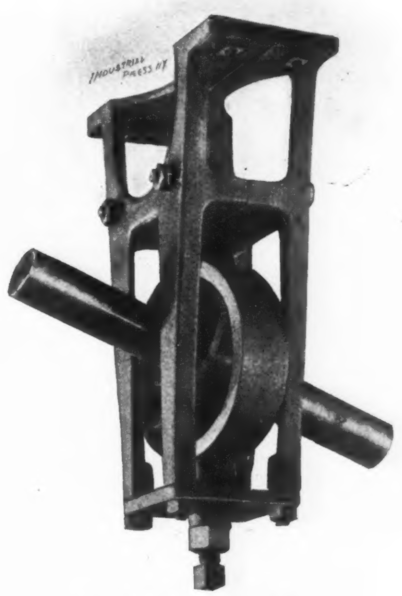


Fig. 1. Ball and Socket Hanger.

In Fig. 1 is a view of a hanger as it appears when suspended from the ceiling and the inclination of the short shaft which projects through the bearing shows to how great an extent this bearing can accommodate itself to the angularity of the shafting. The design of both the hanger and the bearing is along original lines. The frame consists of two main castings bolted together, and there are an upper and lower horizontal plate for the support of the bearing. A ball bearing is used and the parts of the bearing are contained within a ball-and-

socket joint which allows the inclination of the shaft shown in Fig. 1. The ball-and-socket joint is formed by means of two rings, one of which is spherical outside and the other spherical inside. The outer ring is split in a vertical plane so that it can be fitted over the inside ring, and it has two trunnions by which the ring is pivoted to the upper and lower plates mentioned above. The joint in this ring passes through the trunnions, and the two halves of the ring are held together by two caps, one of which fits over each trunnion. These caps are held in place by setscrews. One of the setscrews is seen projecting below the hanger in Fig. 1, while the upper one passes through the upper horizontal plate. The runways for the balls are hardened and ground. The ring forming the internal runway of the ball bearing is bored large enough to accommodate a taper bushing which fits over the shaft, and by changing these bushings, which can be done very easily, each countershaft is adapted to several diameters of shafts without making any further change, and thus it is not necessary to have many sizes of hangers to accommodate all sizes of shafts. The manufacturers now make three sizes of hangers, which are sufficient for any ordinary plant.

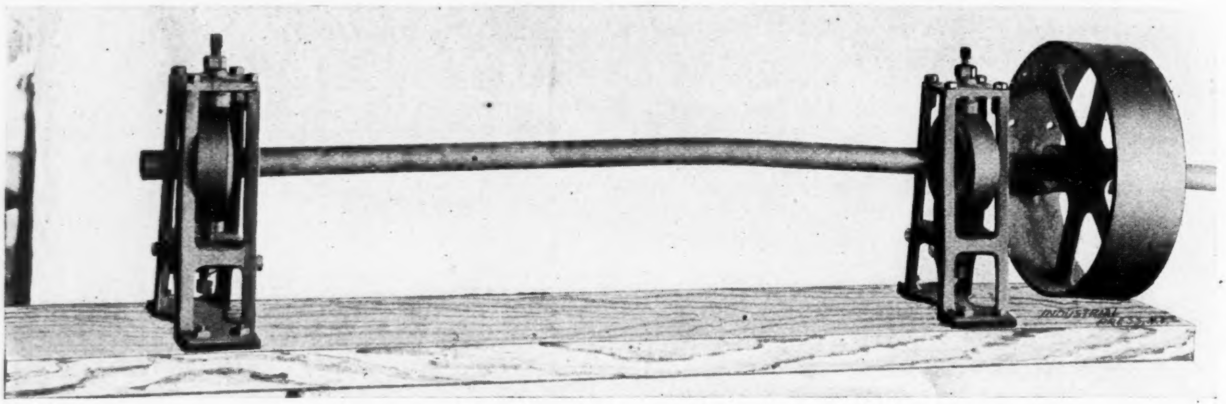


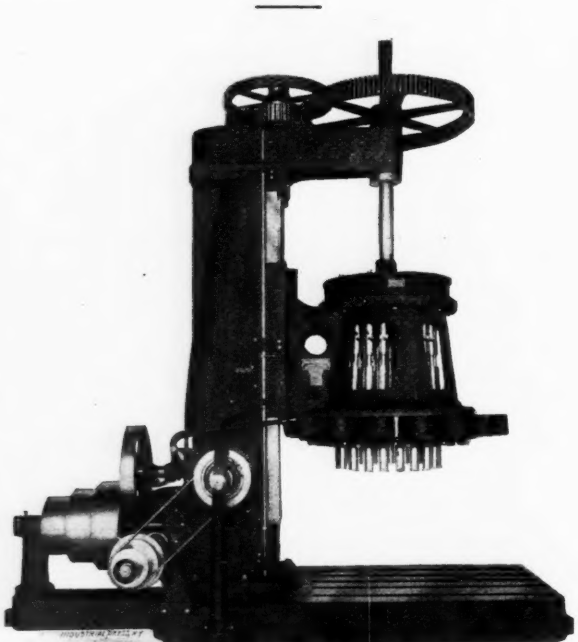
Fig. 2. A Pair of Ball and Socket Hangers being Tested with a Crooked Shaft.

Fig. 2 shows two of the hangers mounted on a plank to test their ability to operate smoothly when supporting a very crooked shaft. A 1 7-16-inch shaft was bent as shown and was operated at 180 revolutions per minute with ease by means of a twine serving as a belt to drive the pulley. The conditions of alignment of the shaft were so bad that a belt would not stay on the pulley. We have received a photograph taken while this shaft was running, which, however, is not reproduced.

HIGH SPEED ADJUSTABLE MULTIPLE DRILL.

The accompanying half-tone illustrates a new twenty-spindle multiple drill that has recently been designed and built by the Baush Machine Tool Co., Springfield, Mass., for drilling valves at a high rate of speed. The machine is driven by a 7-inch belt and is provided with roller and ball bearings. The head is moved up and down on the post by a screw operated by an automatic feed and stop device, which makes it very easy to handle and rapid to operate, besides relieving the workman of much unnecessary handling. A quick return is also provided.

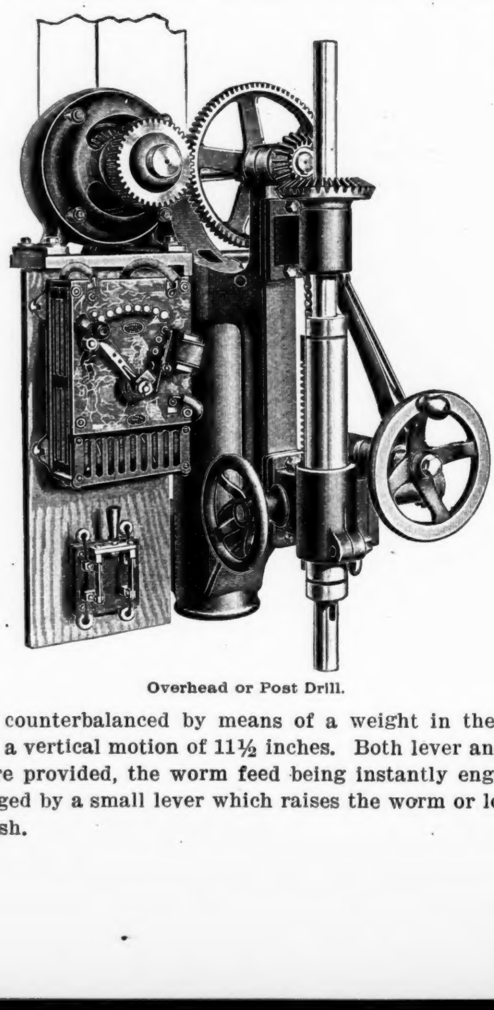
High-speed tool steel drills are used in these machines with speeds ranging from 500 revolutions per minute for ½ inch drills to 175 revolutions for 1¾ inch drills, and with corresponding feeds of 3¼ and 1¾ inches per minute respectively. These speeds are based on a peripheral speed of 65 feet per minute. The feeds increase from 1 inch of feed per 150 revolutions to 1 inch of feed per 100 revolutions. The Bocorselski joint is used throughout for transmitting motion from the central spindle to the different drills. The total weight of this drill is about 23,000 pounds.



Twenty-spindle High-speed Multiple Drill.

ELECTRICALLY-DRIVEN OVERHEAD DRILL.

A new electrically-operated, overhead drill has just been brought out by Boynton & Plummer, Worcester, Mass., which is designed to be placed on a beam or post so that work of any diameter may be brought under it. The spindle of this drill is counterbalanced by means of a weight in the frame, and has a vertical motion of 11½ inches. Both lever and worm feeds are provided, the worm feed being instantly engaged or disengaged by a small lever which raises the worm or lowers it into mesh.



Overhead or Post Drill.

A shelf is attached to the side of the frame and on this is mounted a 220-volt, ½-horse power motor built by the Northern Electrical Mfg. Co., Madison, Wis. This runs at a speed of 900 revolutions per minute and carries on its shaft a rawhide pinion which meshes with the driving gear on the drill. Bevel gear connections, between the driving gear shaft and the splined spindle, give a maximum speed to the drill of 270 revolutions per minute. The illustration shows the arrangement of rheostat and switch which are so placed as to be convenient to the operator. The same drill may, if desired, be furnished with belt-driving pulley and the motor omitted.

THE DIAMO-CARBO EMERY WHEEL DRESSER.

One of the most expensive requisites of the tool room is the black diamond which is required for truing and shaping emery and other grinding wheels. In order to afford a means for doing this with a less expensive tool the Desmond-Stephan Manufacturing Co., Urbana, Ohio, have placed upon the market the emery wheel dresser which is illustrated below. This con-

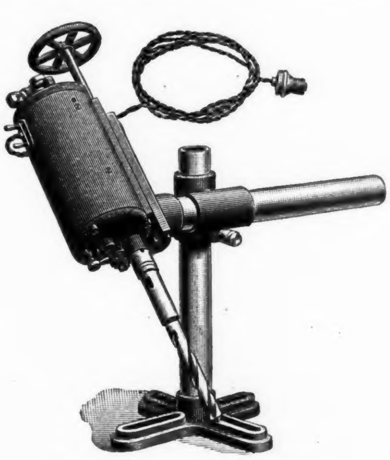
Diamo-Carbo Emery Wheel Dresser.

sists of a brass or copper tube which is filled, by a vitrifying process, with an abrasive of sufficient hardness to cut emery or carborundum wheels. On the outside of this tube is an adjustable collar, which is moved so as to form a back stop over the emery wheel rest. The dresser is then passed lightly over the surface of the wheel, which it trues or shapes to any desired form.

PORTABLE ELECTRIC "SCOTCH" DRILL.

The accompanying engraving of a portable electrically-driven Scotch drill appeared in this department in the November number and is reproduced herewith, because the engraving was inadvertently placed with the description of another tool, without suitable title, so that it was not clear who manufactured the drill. This drill is made by the Hisey-Wolf Machine Co., Cincinnati, O. It has a capacity for holes up to ⅞-inch diameter, and a feed of 7 inches by the hand wheel.

The adjustable bracket upon which the drill is mounted has a movement of 20 inches in any direction, making the

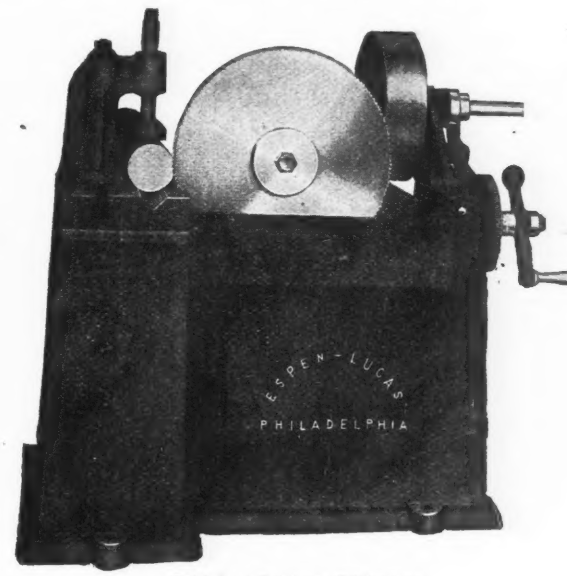


Electrically-driven "Scotch" Drill.

machine universal. The drill has two speeds, the power being obtained from any incandescent lamp circuit where direct current is employed, the motor being wound for 110 and 220 volts. The motor is inclosed and dust proof and is suitably geared to develop the necessary power up to the capacity of the drill. The machine may be carried from point to point around the shop, its sphere of action being limited only by the length of the flexible wire connection. Its weight is 95 pounds and extreme height 30 inches over all.

COLD SAW CUTTING-OFF MACHINE.

A new cold saw cutting-off machine that has just been designed and built by the Espen-Lucas Machine Works, Philadelphia, Pa., is illustrated in the half-tone herewith. It has a capacity for cutting 4-inch round stock, and structural shapes up to 6-inch I-beams, at one cut. The saw has variable automatic feed, automatic safety stop, and swivel clamp on the platen for holding different shapes and sizes of material



Cold Saw Cutting-off Machine.

to be cut straight or at an angle. This clamp may, if desired, be entirely removed, allowing jig work to be placed on the table. The machine is driven by steel worm and phosphor bronze worm wheel running in an oil bath. The design of the machine is such as to occupy very little floor room but at the same time the materials of construction are so disposed as to give the unusual stiffness necessary for cutting the large sizes of stock for which the machine is built. Arrangement is made for carrying saw blades up to 14 inches in diameter.

* * *

OBITUARY.

James N. Skinner, late superintendent of the Skinner Chuck Co., New Britain, Conn., died at his home in that city November 8. Early in his career Mr. Skinner served in the regiment of the Connecticut Volunteers during the Civil War, and later entered the service of the Government at the Springfield Armory. After this he was employed by the Howe Sewing Machine Co., of Bridgeport, and from there went to the works of the E. Horton & Son Co., at Windsor Locks, where he remained for fourteen years. It was while with this concern that he took out several patents on chucks, and in 1887, when the Skinner Chuck Co. was organized, he was elected superintendent and director of that company, a position which he held until his death. Mr. Skinner was well known as the originator of several inventions and of many improvements in the line of manufacture to which he devoted his life.

* * *

DECEMBER MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The forty-eighth meeting of the American Society of Mechanical Engineers will take place December 1 to 4. At the opening session, December 1st, Mr. James M. Dodge, president of the society, will deliver the annual address, "The Money Value of Technical Training." The papers for the following sessions are as follows:

Wednesday morning, December 2, at 113 West 40th St.—"Is Anything the Matter with Piece Work?" by Frank Richards; "Modifying Systems of Management," H. L. Gantt; "Slide Rules for the Machine Shop as a Part of the Taylor System of Management," by C. G. Barth; "What are the New Machine Tools to be?" by John E. Sweet; "Suggestions for Shop Construction," by F. A. Scheffler.

Thursday morning, December 3, at Stevens Institute of Tech-

nology.—"The Pitot Tube," W. B. Gregory; "Method of Determining Rates and Prices for Electric Power," F. B. Perry; "Three and Four Wire Multiple Voltage Systems," Louis A. Gillet; "Test of a Compound Engine Using Superheated Steam," D. S. Jacobus; "The Pressure Temperature Curve of Sulphurous Anhydride (SO)," E. F. Miller; "Construction and Efficiency of a Fleming Four-valve Engine," Benj. T. Allen.

Friday morning, December 4, at the Society House, 12 West 31st St., New York.—"A Compact Gas Engine, Beam Type," C. H. Morgan; "Standard Unit of Refrigeration," J. C. Bertsch; "Series Distilling Apparatus of High Efficiency," W. F. M. Goss; "Air Motors and Air Hammers, Apparatus and Methods for Testing," Max H. Wickhorst; "Valve Motion of Duplex Air Compressor," S. H. Bunnell.

It has been decided to hold the spring meeting, 1904, at Chicago. This will enable members who intend to visit the Louisiana Purchase Exposition to make an easy journey to St. Louis, and will obviate the discomfort incident to a convention in a crowded exposition city.

* * *

TECHNICAL EDUCATION.

Louis Duncan in Engineering Magazine, November, p. 161.

The fault of our technical education in America is that it is too technical and that there is too much instruction. It seems to be the idea that the longer contact the student has with his lecturers or with his text books the more information he will obtain. It does not seem to be considered that information, as such, is not of great importance. It can be obtained easily and cheaply when occasion arises; and the end and aim of a technical education should be not to obtain information, but to apply it. We should not attempt to make mental storehouses of men, but mental factories.

Another thing is this: that to a large extent, the ability of a man to work out any specific problem depends on his being able to make a mental plot of the problem, and to keep it constantly before him. For instance, a railroad proposition for a city, presented to an engineer, involves an infinity of different considerations—the population of the different districts of the city, the character of the population, the growth, the franchises under which the road is to be built, the political complexion of the city government, the question as to whether the capitalists who are building the road intend to operate it or to sell it—these and a hundred other considerations must form part of the plan adopted. To take all these into account, to keep them constantly before one until the scheme works itself out, requires an imagination that has been developed and not suppressed. A large part of the work is done outside of any office—in street cars, at dinner—unconsciously to a certain extent.

I wish specially to emphasize this point. The amount of work done at desk or before a drawing-board is a very small proportion of the total work needed for a large engineering proposition. The successful engineers are those who can see the problem as plainly while they are walking on the street as they can see it on a blue-print.

I saw some time ago in one of the daily papers a discussion of the requisites for success in life, and some one, I think it was Mr. Cleveland, summed things up by giving as the three requisites—character, persistence, and intellect. The fact that intellect was placed third on the list surprised many people, but this is true. Suppose a brilliant man does a certain piece of work in a certain time; another man does the same work in twice the time; the first is usually considered has having about twice the intellect of the second, and by the ordinary definition of intellect, which emphasizes the time element, this is true. But any one with average brains can work out any reasonable proposition, provided he works at it long enough, and his ability, of which I have spoken—the ability to keep a proposition constantly in front of one, the quality of imagination—constitutes the difference between the finally effective man and the so-called brilliant thinker. Brilliancy is merely the time-factor of application. Newton said that his success was not due to the fact that he was smarter than other people, but to the fact that he thought more than other people.

In looking over the list of successful engineers (I am speaking now of electrical engineers, because I know very little of any other branch), we do not find that we can point to any one institution as having produced more successful engineers than any other in such a way as to make the difference marked. In fact, I am afraid that our largest and best equipped institutions do not show as fair a percentage of leading engineers as some of the smaller, poorly equipped colleges. I think this is due to two things; the first is that the larger institutions have presented courses including more instruction than can be given in smaller institutions, and I believe that at least half of this has done harm rather than good. The other cause is obvious, i. e., that in the smaller institutions the students are more directly in contact with the instructors, and that they do not have the facilities for work that the more ambitious colleges have; that is, when an experiment is to be tried, the ingenuity of the student, and not his patience, is exercised.

The power mechanism for the vertical traverse of cross-rails on planers and boring mills has generally been made to give the same speed whether going up or down. It is obvious that the power required when moving upward is much greater than when going down, but with the mechanism using the ordinary tumbler gears for reversing the direction of travel, it has not been easy to vary the ratio, consequently it has usually been made in a 1 to 1 ratio. If, however, a friction clutch is used for reversing the direction of vertical traverse, the ratio is easily made whatever good design would suggest. We believe the Cincinnati Planer Company was the first to do this regularly, their planers all being made with the ratio of upward to downward travel as 1 to 2. The King Machine Tool Company have applied the same idea on the new line of boring mills which they are bringing out. The plan of using friction clutches instead of tumbler gears has another advantage, and that is there is less racket, especially when spiral gears are used in the combination.

Commissioner Lindenthal of the New York Bridge Department announces that the new Williamsburg bridge (New York to Brooklyn) will be opened to pedestrians and teams about December 19. The approaches are rapidly nearing completion, and the bridge itself is finished save for minor details which will be ready by the time the approaches are done. It is not expected that street cars will run over it for some time as it has not yet been decided what company will be granted the privilege. The Brooklyn Rapid Transit and the Interborough companies are competing for it.

The great advance in the art of forming difficult metal shapes by heavy pressure is indicated by the organization of a company in Milwaukee, Wis. (the American Standard Steel Fitting Company), to make pressed steel pipe fittings from ordinary boiler-plate steel. These fittings will, it is said, be somewhat more expensive than cast iron, and about the same price as steel castings. Being seamless and non-porous such fittings should be superior to all castings, and, therefore, particularly acceptable in refrigerating plants because of the well-known difficulties of handling ammonia in extensive pipe systems without serious loss, due to defective fittings, etc.

* * *

FRESH FROM THE PRESS.

THE MECHANICAL ENGINEERS' POCKETBOOK, by D. K. Clark. Published in America by the D. Van Nostrand Company, New York. 690 pages. Illustrated. Price, $3.00.

This is a new edition of Clark's well-known English handbook. Mr. Clark died previous to its complete revision and Mr. H. H. P. Powles, an English engineer, is responsible for the corrections, revision and additions made necessary in bringing out this edition. The book is handsomely bound in leather, with round corners, and is very convenient for use.

ENGINEERING PRELIMINARIES FOR AN INTERURBAN ELECTRIC RAILWAY, by Ernest Gonzenbach. Published by the McGraw Publishing Company, New York. Illustrated. Price, $1.00.

As the title indicates, this book of 71 pages is a review of the engineering preliminaries that should be considered in the projection of an interurban electric railway, which are taken up under the captions: Estimated Income, General Requirements, Third Rail vs. Trolley, Location, Roadbed and Track, Rolling Stock, Electrical Car Equipment, Car Shops, Power Stations, Transmission Line, Distributing System, Third Rail, Accessories, Estimate, Operation, etc.

FOWLER'S MECHANICAL ENGINEERS' POCKETBOOK FOR 1904, edited by William H. Fowler, published by the Scientific Publishing Company, Manchester, Eng., and for sale in this country by the Derry-Collard Company, New York. Price, 60 cents.

This book has been added to from year to year until now it contains 450 pages of closely printed matter and has a great deal of valuable information upon all branches of mechanical engineering.

The policy of revising this book each year, and adding to it, has made it possible to keep it in touch with recent practice, and much information is gathered within its pages that is not available in any other one place. The index is unusually complete.

COMPRESSED AIR, by William Charles Popplewell. Published by the Scientific Publishing Company, Manchester, Eng., and for sale in this country by the Derry-Collard Company, New York. 285 8vo pages. Illustrated. Price, $3.00.

This is a new book treating of the theory and practice of pneumatic power transmission. There are descriptions of several types of air compressors or motors, and of the numerous compressed air tools that have been placed on the market during the past few years. There is also a brief treatment of air transmission and the efficiency tests of compressors and transmission system. The book is almost entirely descriptive, but one chapter being devoted to compressed air calculations.

AIRBRAKE CATECHISM, by Robert Blackall, Airbrake Instructor and Inspector with Westinghouse Airbrake Company. 304 12mo pages and 98 illustrations. Published by Norman W. Henley & Son, 132 Nassau Street, New York. Price, $2.00.

An extended review of this book, which may be said to be the standard catechism of the airbrake, is not necessary; it is too well known to require it, having passed through seventeen editions. The present edition, the eighteenth, has been revised and brought thoroughly up-to-date. It is a complete study of the airbrake and signal equipment, and we are told that it has been endorsed and is used by nearly every instructor and examiner on the railways of the United States. Two large Westinghouse airbrake educational charts, each 14 x 50 inches, printed in colors, accompany each book.

ELECTRIC RAILWAY ECONOMICS, by W. C. Gotschall. 252 pages. Illustrated. Published by the McGraw Publishing Company, New York. Price, $2.00.

This book is based on a series of lectures delivered by the author at Lehigh University upon the economics and preliminary engineering of high-speed and heavy traction interurban electric railways. The great interest that has been aroused in high-speed electric railways by the recent tests abroad and the strong probabilities of very extensive work in this line in the near future here, make any authoritative literature on the subject of timely interest and most acceptable to engineers and others. The work not only takes up the engineering features of survey and construction, but also treats of the organization of the operating department and the economic considerations determining the magnitude and details of the proposed road. Several folded diagrams and cuts are presented. The appendices give the specifications for a moderate-sized interurban road and a bibliography referring to important articles on high-speed and heavy traction that have appeared in some of the various technical journals.

HOME MECHANICS FOR AMATEURS, by the late George M. Hopkins, of the editorial staff of the Scientific American. Published by Munn & Co., New York. 370 pages. Illustrated. Price, $1.50.

This is a companion book to the "Experimental Science" by the same author, which has had a very large sale. As the title of the book indicates, it is for the amateur, not for the workman who understands practical methods or who has practical work to do. In this country the amateur is mainly the American boy. Amateur work in wood and metal is not so popular here as in England, but nevertheless this book, which seems to be practical, will probably appeal to many, both old and young, who like to make knicknacks and all sorts of devices for use about the house, but who have not the practical knowledge necessary to either invent them or to make them without instructions from outside. The chapters are seven in number, taking up woodwork, household ornaments, metal work, model engines and boilers, meteorological instruments, telescopes and microscopes and electricity. Mr. Hopkins, the author, died just previous to the completion of the work, but he had given the proofs their final revision, so that the book is completely the work of its author.

ENGINE TESTS AND BOILER EFFICIENCIES, by J. Buchetti. Translated by Alexander Russell, an English authority, and published in this country, by Norman W. Henley & Son, 132 Nassau Street, New York. 256 8vo pages. Illustrated. Price, $3.00.

The first hundred pages of this book are devoted to an explanation of the indicator and indicator diagram, with descriptions of several kinds of instruments, some of which are not entirely familiar to American readers. After this follow chapters on testing gas and oil engines; the measurement of brake horse power; the use of a dynamo as a brake, and a very brief chapter on testing steam turbines. The book concludes with chapters on the properties of steam, evaporation, combustion, and an appendix containing notes, tables, etc. All the tables and calculations which in the original appeared in the metric or French units have been converted into English units, so that the book can easily be used by readers in this country. The subject is clearly treated and as it undoubtedly fairly represents continental practice, the volume should prove of considerable interest to consulting engineers who are engaged in testing according to methods which have become standard in the United States. From the fact, however, that continental practice differs somewhat from our own, the book would not be as well adapted to a student as one which followed the standard methods of this country.

LOCOMOTIVE BREAKDOWNS, EMERGENCIES AND THEIR REMEDIES, by George L. Fowler, M.E., 250 12mo pages and 96 illustrations. Published by Norman W. Henley & Son, 132 Nassau Street, New York. Price, $1.50.

This book treats, in catechism form, of the various accidents and breakdowns to which the steam locomotive is liable, and gives in each case a practical and simple method of handling same, so that a locomotive may proceed under its own steam or be safely towed in. It is a book containing many practical suggestions that should be of value to almost every locomotive engineer, wrecking boss, roundhouse foreman, shop foreman and others desiring to make themselves proficient in the handling of locomotive repairs and emergencies. For instance the first chapter, treating of valve defects, tells how to locate and distinguish valve and piston steam leaks or "blows," as they are commonly known in railway parlance, and it alone should be worth the price of the book to those having to do with these sometimes obscure and puzzling defects. Besides the chapters treating of road repairs to valves, steam chests, cylinders, pistons, guides, crossheads, running gear, springs, frames, throttles, trucks, airpumps, injectors, lubricators, etc., a chapter is devoted to certain methods of shop repairs that are good; also one on aid to the injured. When it is considered that often a man's life is sacrificed simply because of the ignorance of his companions as to the proper treatment of a ruptured artery, it certainly seems worth while to instill some elementary surgical knowledge into the training of railway men.

MACHINE DESIGN. Part I. Fastenings. By William Ledyard Cathcart, adjunct professor of mechanical engineering, Columbia University. 290 8vo pages. Illustrated. Published by D. Van Nostrand Company, 23 Murray Street, New York. Price, $3.00.

Several years ago we gave favorable notice of the work on machine design by Prof. Forrest R. Jones which was issued at that time, and said that it was of peculiar interest as being the first comprehensive treatise on the subject which covered machine design very thoroughly, being comparable in this respect to the English work by Unwin. This new book by Prof. Cathcart should also receive favorable notice and, although not a pioneer in its field, like the other treatise, is none the less interesting, since it apparently is the beginning of what will eventually be a more extended and perhaps complete, though we judge hardly a more workable, presentation than the volumes by Prof. Jones. The thoroughness with which Prof. Cathcart has gone into the matter is evident from the fact that this whole volume is devoted to this one subject of fastenings. The first chapter gives the most complete and satisfactory treatment with which we are acquainted, of shrinkage and pressure joints. The treatment is theoretical, supplemented by tables, several of which have been made up from similar tables appearing in MACHINERY. The chapter concludes with a treatment of shrinkage in gun construction. Following this come screw fastenings, riveted joints, keyed and pin joints. Throughout the work there are theoretical mathematical discussions and tabulated sizes, for convenient reference. The book abounds in tables, not only of dimensions, but of strength of materials, the properties of matter, etc. Considerable attention is given to U. S. Government specifications for screws, riveted joints, etc. To illustrate what is done in the way of theory may be mentioned the stresses in screws, torsion due to thread friction, stresses in nuts, efficiency of the screw. Altogether the volume is to be recommended as an advanced and practical reference work on such parts of machine design as its pages treat.

THE GAS ENGINE, by F. R. Hutton, professor of mechanical engineering, Columbia University. 483 8vo pages. Illustrated. Published by John Wiley & Sons, New York. Price, $5.00.

The most widely-known books on the gas engine at the present time are the three English works by Donkin, Robinson, and Clerk. These consider the British types of gas engines, and while they go into the subject exhaustively, they are not of such character as to place the reader in touch with the wonderful gas engine development in this country in the past few years. Up to the time of the appearance of Prof. Hutton's volume there has been no comprehensive American treatise on the gas engine, such as have appeared being either of a popular nature or else dealing specifically with gas engine design. The present volume is intended to be a comprehensive American treatment, unsparing in its theoretical deductions, with due consideration of the application of theory to practice. The most exhaustive chapter, and one which will be appreciated by the investigator, although deeper than the average student would be anxious to go into—unless he were an accomplished mathematician—is one on the theoretical analysis of the gas engine. This chapter takes up the different gas engine cycles more completely than any previous work. The volume presents what is latest in connection with the blast furnace and producer gas apparatus. The first three chapters are introductory, reviewing the physical properties of hydrocarbon for power purposes, touching upon the various gases available, for use in an internal combustion engine. Following this is a discussion of a heat engine cycle; chapters on gas, gasoline, kerosene, and alcohol engines; carbureters; methods of ignition; governing, etc. There is a chapter on experiments with explosive mixtures, one on the performance of gas engines by tests, and one on the manipulation of gas engines which considers the ills that such machines are heir to. While many of the chapters are easily read and free from mathematics, the work on the whole is an advanced treatise and one to interest the mechanical engineer or designer.

The following books have been received:

A TEXTBOOK OF ELECTRICAL MACHINERY, Vol. I. Electric Magnetism and Electrostatic Circuits, by Profs. Ryan and Norris, of Cornell University, and Mr. George L. Hoxie. Published by John Wiley & Sons, New York. Price, $2.50.

This is a theoretical textbook for students' use.

THE ARITHMETIC OF ELECTRICITY, by T. O'Connor Sloane. Published by Norman W. Henley & Son, 132 Nassau Street, New York. 160 12mo pages. Illustrated. Price, $1.00.

This is the sixteenth edition, revised and enlarged, of this popular work on electricity.

ELECTRIC TOY-MAKING FOR AMATEURS, by T. O'Connor Sloane. 185 12mo pages. Illustrated. Price $1.00.

This is the fifteenth edition, revised, to which several chapters have been added containing descriptions of a number of new and interesting devices.

MANUAL OF SCREW CUTTING, by William Simpson, Lock Box 8, Wollaston, Mass.

This little handbook deals with screw cutting and change gears, has several useful tables, and gives directions for making a number of calculations, such as sizes of pulleys, etc. It contains 73 pages. This is the sixth edition.

ROOF FRAMING MADE EASY, by Owen B. McGinnis. Published by the Industrial Publication Company, New York. Second edition. Price, $1.00.

St. Nicholas, for December, is a real Christmas-stocking number, brim full of holiday stories and pictures, verse and fun. "An Interrupted Auction," by Carolyn Wells; "The Road to Fairyland," by Ernest Thompson Seton; "St. Saturday," by Henry Johnstone, with a page picture of the old Saint; "Happy Days," by Sarah S. Stilwell, and there are other shorter jingles pleasant to read between the stories.

Temple Bailey's "The Bachelor's Doll," is a delightful tale. In "The Three Caskets" George M. R. Twose retells for young readers the story of Portia and her three caskets. Ralph D. Paine gives an account of "A Chinese Army That Cheered for Yale"; Anna Porter Rex tells of "President Washington's Turkey Dinner"; Cyrus Townsend Brady, a humorous account of "The Baby's Adventurous Day—and Mine"; the "Adventures of a Tin Soldier" are recounted by Charles Raymond Macauley; Julian King Colford writes interestingly of "The Signs of Old London." New chapters of B. L. Farjeon's "A Comedy in Wax" carry the characters through many exciting adventures, etc.

The *Century* for December is particularly attractive and entertaining. There is an artistic cover and quite a number of pictures in color throughout the magazine. Of course a number of articles have the Christmas flavor, such, for instance, as "A Christmas Rescue," by Alfred Bigelow Paine, illustrated with pictures by Miss Cory; "How Santy Claws Treated Pop Baker," by the late Elizabeth Cherry Waltz; "Christmas Mangers," by Emma E. Porter, and "A Christmas Dilemma." Alice Katherine Fallows in "Temptations to be Good" sets forth certain good influences on the New York East Side boy, while Lucy Derby Fuller contributes a reminiscent paper on "Phillips Brooks and the Girls' Club." Another instalment of the new Thackeray find, consisting of his letters to the Baxter family of New York and some of his drawings, show him in intimate and lovable moods. There is a group of negro songs by Joel Chandler Harris, Paul Laurence Dunbar and others, with pictures by A. B. Frost. The range of fiction is further enlarged by a story by Roy Rolfe Gilson, "The Poet of a Day," illustrated; a humorous story by Maurice Francis Egan; a character sketch by J. J. Bell, a story of peasant life entitled "The Promise," by Maarten Maartens, the Dutch novelist, etc. Ernest Thompson Seton has another group of sketches of nature, entitled "Fable and Woodmyth." There is a curious paper by André Saglio on "The Bigoudines" of Brittany, with illustrations; a sketch entitled "Chrysanthemums," by Maurice Maeterlinck. Dr. James M. Buckley writes of "Fanaticism in the United States," in which there is additional reference to "Elijah the Restorer." Franklin Clarkin describes "The Daily Walk of the Walking Delegate."

NEW TRADE LITERATURE.

THE BUFFALO STEAM PUMP COMPANY, Buffalo, N. Y. Leaflet describing the Buffalo Underwriter fire pump.

E. G. SMITH, Columbia, Pa. Circular, just published, of the calipers and levels manufactured, will be sent to any one interested.

THE AMERICAN DIESEL ENGINE COMPANY, 11 Broadway, New York. Pamphlet describing and illustrating the Diesel engine, American type. This engine is here treated very fully and illustrations show its pump, motor, admission valve, etc.

THE CINCINNATI PUNCH & SHEAR COMPANY, Cincinnati, O. Catalogue No. 9, illustrating and describing the full line of power punching and shearing machinery, rolls, etc., designed and built by this company.

THE DETROIT PUMP COMPANY, Detroit, Mich. Catalogue of the Blackmer rotary pump. Illustrations show its interior construction, also the No. 4 and No. 6 belt pump, a No. 4 special and a No. 4 hand pump.

WARREN WEBSTER & CO., Camden, N. J. Part 5 of general catalogue, which describes and illustrates the Webster motor valve for use in connection with the Webster system of low-pressure steam circulation for heating.

H. B. UNDERWOOD & CO., Philadelphia, Pa. Illustrated catalogue, 1903, of portable tools for railway repair shops. Boring bars, for various purposes, crank-pin turning machines, portable milling machine, portable rotary planing machine, valve seat rotary planing machine, etc., are here described.

THE DIVINE BROTHERS COMPANY, Utica, N. Y. Circular descriptive of polishing wheels, samples of which are shown. These include sheep skin wheels, bull neck solid-leather wheels, wool felt, canvas, sheepskin, compress felt and cloth wheels. The circular describes each style.

THE E. F. REECE COMPANY, Greenfield, Mass. Catalogue No. 5 of screw plates, taps, dies, etc. The different sizes and varieties of these tools are given, together with price: and the manufacturers state that for taps and dies of special form, size or pitch not listed in this catalogue prices will be quoted on application.

THE AMERICAN TOOL WORKS COMPANY, Cincinnati, O. Illustrated booklet describing several types of improved metal-working machinery designed and built by this company. These include engine lathes, a high-speed lathe, crank shapers, standard metal planers, drill presses, radial drills and a 37-inch boring and turning mill.

THE CROCKER-WHEELER COMPANY, Ampere, N. J. Bulletin No. 39 describing the equipment of the Orange, N. J., Brewery with the Crocker-Wheeler system of electric motor drive. Different views show: The electric generating units, the power plant where the refrigerating machines and electric generators are installed; the cooker, driven by motor, and a pump and a keg-washing machine, both motor driven.

THE PEERLESS RUBBER COMPANY, 16 Warren Street, New York. Illustrated catalogue No. 60, October, 1903, of rubber goods for mechanical purposes. This book contains 150 pages and lists packings of all kinds for various purposes, gaskets, a large line of rubber belting, rubber hose, rubber tubing, rubber valves—in fact everything in this line—in a very complete manner. All the varieties of goods are illustrated and briefly described.

THE PRENTICE BROS. COMPANY, Worcester, Mass. Booklet entitled "Radial Efficiency," which describes the radial drilling machines of the company's make. They state incidentally that they have built, up to July 1, 1903, 2,064 radial drills, and this booklet calls attention to the novel and important features of their new line of radials, which are described quite fully and whose parts are illustrated by half-tone cuts.

THE WOOLLEY FOUNDRY & MACHINE WORKS, Anderson, Ind. Illustrated catalogue, standard size, of the "Burger" gas engines. The company claim for these engines simplicity of design and construction and small number of working parts; durability and freedom from repairs; ease in starting and operating, and economy in consumption of fuel. The Burger type of engine and its various parts are here shown.

THE NATIONAL AUTOMATIC TOOL COMPANY, Dayton, O. Illustrated catalogue of automatic drilling and reaming machinery. This contains handsome illustrations of "Nutting's" automatic universal multiple spindle drill press, described some time back in the columns of our paper; of the Nutting automatic multiple drilling machine for sewing machine arms, and of the Nutting rotary platen automatic multiple drill which is described elsewhere in this issue.

THE B. F. BARNES COMPANY, Rockford, Ill. Illustrated catalogue of drills, lathes and a water tool grinder. The drills range from the 12-inch to the 31-inch size, and are built with from two to six spindles, in many varieties. One illustration shows a battery of six 20-inch drills, with round base and power feed, which is furnished with various combinations of feed required and arranged for all sizes of drills. The lathes include 9 and 11-inch screw cutting lathes.

THE ABENDROTH & ROOT MANUFACTURING CO., Newburg and New York. Advertising literature of the products of this company. A catalogue of 64 pages illustrates and describes their "Root" water-tube boilers, and half-tone views show the method of replacing a tube in these boilers, the operation of removing and replacing requiring but 48 minutes. A large number of cuts show prominent plants and public buildings equipped with "Root" boilers. A price list, June, 1903, of the "Root" spiral riveted pipe and a number of other pamphlets dealing with the "Root" boilers and pipe, have also been received.

THE BUFFALO FORGE COMPANY, Buffalo, N. Y. Sectional catalogues of Buffalo mechanical forced draft and of steel pressure blowers, just issued. These are attractive pamphlets, the first describing the works of the company and the fan for forced draft which they manufacture. A number of interesting views illustrate the many varieties of fans, some being shown applied to boilers, engines, pumps, etc. The booklet on blowers illustrates the various types, and tables of their dimensions and the prices are given. The Buffalo automatic cut-off engine, of their manufacture, is also illustrated.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J. "Graphite Suggestions," an attractive booklet treating, as the title indicates, of the company's product—graphite. This is made for a great variety of purposes, as follows: For the extensive line of pencils, about one thousand different kinds, which the company make; for use in the foundry; for lubricating purposes; for belt dressing; as a pipe joint compound; for stove polish, etc. The Dixon Company here state that they issue special circulars or pamphlets of their many and various productions, in which each is treated individually and fully.

THE MCCULLOUGH-DALZELL CRUCIBLE COMPANY, Pittsburg, Pa. Folder calling attention to the crucibles and plumbago products of this company. This concern have been making crucibles exclusively for thirty years and have a very extended trade among the steel industries. They state that their crucibles run uniform, that their life under like conditions will last through the greatest number of heats, etc., and that the material used in their manufacture is the best procurable. They also inform us that they are one of the four largest importers of plumbago in this country and being able to pick out their stock always procure the best material available.

THE AMERICAN BLOWER COMPANY, Detroit, Mich. Three illustrated catalogues of the company's products, as follows: Illustrated sectional catalogue, No. 118, second edition, treating of the "A B C" system of mechanical draft, forced and induced by the use of blowers and fans, and several applications of these fans and blowers to boilers in various plants are shown; catalogue No. 145 (second edition) dealing with the fan system of heating and ventilation as applied to manufacturing establishments; catalogue No. 155 illustrating and describing the "A B C" steel plate fans. All three catalogues are handsomely gotten up.

THE HESS MACHINE COMPANY, 1002 Pennsylvania Building, Philadelphia, Pa. Illustrated catalogue, standard size, of milling machines and milling cutters. The company's 30, 36 and 42-inch machines for heavy work are listed here and they state they are prepared to widen out these machines to take in wider work, and they will build to order larger machines of proportionately greater power. Their specialty is heavy milling, fast milling and combined heavy and fast milling. The machines are furnished with electric drive when desired. This type of milling machine was described in MACHINERY in the September, 1903, issue.

THE INGERSOLL-SERGEANT DRILL COMPANY, 26 Cortlandt Street, New York. Form No. 4—an advance copy of the new pamphlet which is being prepared for publication by the company, treating of the air hammers, drills, couplings, etc., manufactured. The Haeseler hammers, which were illustrated in MACHINERY, July, 1903, issue, are here described and illustrated in detail. The chipping hammers are made in five standard sizes; the riveting hammers in three sizes. The duplex pneumatic "holder-on," for use when hand-riveting, a portable oil rivet forge, the Haeseler No. 3 piston drill, a radial drilling frame for use with No. 3 drill, a rotary breast drill, etc., are also shown.

MANUFACTURERS' NOTES.

THE WALWORTH MANUFACTURING COMPANY are building a new brass foundry adjoining their works in South Boston, Mass., which will be 54 x 260 feet, six stories high.

THE NATIONAL STEEL FOUNDRY COMPANY, New Haven, Conn., announce the establishment of an acid open-hearth steel casting plant, the first pouring to occur about December 1, 1903.

THE STEEL SET DIAMOND COMPANY, New York City, manufacturers of emery wheel dressers, wire dies, etc., have removed from 275 Water Street to 36 Gold Street, New York.

THE LUNKENHEIMER COMPANY, Cincinnati, O., advise us that they have opened a branch office in Paris, France, at 24 Boulevard Voltaire, where they will carry a complete stock of their goods.

FRANK MOSSBERG COMPANY, Attleboro, Mass., manufacturers of metal stampings and metal machinery, have sent us a sample of their work in the shape of a handsome nickeled paper knife for opening letters, etc.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., inform us that they have established headquarters for the Southern representative of their Washington office, Mr. S. M. Conant, at 425 Empire Building, Atlanta, Ga.

THE PEDRICK & AYER COMPANY, Plainfield, N. J., announce that Robert O. Cumback, for several years with the C. R. R. of N. J., and later at the Elizabethport shops on special work, has accepted the position of superintendent of their new plant at Plainfield.

THE L. S. STARRETT COMPANY, Athol, Mass., manufacturers of fine mechanical tools, have purchased the fine tool business of the J. Stevens Arms & Tool Company, of Chicopee Falls, Mass., including the entire stock of tools made up and in process, special tools and fixtures for manufacturing, patents and good will.

THE AMERICAN TAP & DIE COMPANY held a meeting of the directors October 21, at which Mr. Edward Wilbur tendered his resignation and J. Henry Nichols was elected president. It is the intention of the company to place its line of dies on the market January 1, 1904. At present they are making a full line of taps.

THE MOORE DROP FORGING COMPANY, Springfield, Mass., have recently increased their capital stock from $30,000 to $40,000. Mr. A. L. Moore was elected president and manager and Mr. A. H. Chapin, treasurer. The company's new plant is at Brightwood, Mass. It consists of three buildings: A drop shop, 50 x 74 feet; a press room 20 x 40 feet; and a machine shop, 45 x 64 feet.

THE SAVAGE & LOVE COMPANY, 710 South Main Street, Rockford, Ill., manufacturers of engines, boilers, shafting, hangers and pulleys, are getting out a new catalogue which they state will soon be issued and which is to be very comprehensive. They also announce that they have taken over the selling end of the business of the National Engine Company. The Savage & Love Company also build woodworking machinery.

THE INGERSOLL-SERGEANT DRILL CO., Cortlandt Street, New York, manufacturers of air and gas compressors, rock drills, etc., announce that while awaiting the completion of their new compressor catalogue, they have issued a temporary reprint, No. 33B, designed to supply their needs until the new one is ready. Besides the matter contained in their former catalogues, it presents some new illustrations, and the tables have been revised and brought up to date.

THE STANDARD ROLLER BEARING COMPANY, Philadelphia, Pa., who recently purchased the ball business of the Grant Tool Company, inform us they have secured as sales manager of the ball business of their company Mr. T. J. Heller, formerly New York agent for the steel ball department of the Federal Manufacturing Company. Mr. Heller will make his headquarters care of the Standard Roller Bearing Company, 48th and Girard Avenue, Philadelphia, Pa.

THE CARBORUNDUM COMPANY, Niagara Falls, N. Y., are again enlarging their plant, having made a contract for 2,000 additional electrical horse power, which will be turned into the works this month, giving the plant a capacity of 10,000,000 pounds of carborundum a year. A new factory site has been secured on which is being erected a new mixing and furnace building, 146 x 134 feet, capable of being extended in two directions.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Armour Institute, Chicago, Ill., announce that Dr. Wm. A. Colledge, F.R.G.S., well-known as lecturer in English at the University of Chicago, has been appointed Dean of the American School of Correspondence at Armour Institute. Dr. Colledge is ably fitted for this position. He was educated at Glasgow and London and has spent many years in travel. By reason of his large acquaintance with unfrequented parts of the earth he was made a Fellow of the Royal Geographical Society. The office of Dean is a new departure for correspondence schools and marks the approach of these schools to the dignity of resident educational institutions.

THE STANDARD ROLLER BEARING CO., Philadelphia, Pa., have purchased the entire ball business of the Grant Tool Co., Franklin, Pa. (formerly of Cleveland, Ohio), and are prepared to fill all orders for the celebrated Grant ball, formerly made by the Grant Ball Co., of Cleveland, Ohio. To supply the demand at once for balls, the business will be run for a short time in Franklin, so that orders can be filled without delay, but it will eventually be moved to Philadelphia and consolidated with the Standard Roller Bearing Company's plant in that city. All orders should be sent to the Standard Roller Bearing Co., Philadelphia, Pa. R. H. Grant, formerly manager of the Grant Ball Co., will have charge of the ball making plant in Philadelphia, and a number of the former employees of the Grant Company will remove from Franklin to Philadelphia, and enter the employ of the Standard Roller Bearing Co.